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XVI INTERNATIONAL CONGRESS OF ENTOMOLOGY

ABSTRACTS

XVI INTERNATIONAL CONGRESS OF ENTOMOLOGY
KYOTO
1980

KYOTO, JAPAN 3–9 AUGUST, 1980

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ABSTRACTS

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* Some of the submitted abstracts were re-typed, because of the unacceptable forms for offset printing. However, due to the tight schedule, correction of the re-typed manuscripts was not enough. Please correct them according to the errata as described above. We apologize for causing so much inconvenience.

Opening Plenary Lecture

INSECTS AS MODEL SYSTEMS IN NEUROSCIENCE. Huber,F.(MPI für Verhaltens physiologie, Seewiesen, FRG)

Insects can be considered as suitable animals for quantitative studies of their behavior and the underlying nervous mechanisms. In this respect they are Model Systems for Neuroscience.

As far as behavior is concerned insects display it under suitable laboratory conditions in a natural fashion. It is rather easy to work out a complete ETHOGRAM of the behavior of interest and to study behavioral patterns quantitatively.This will outlined in the field of Acustic Behavior in Orthopterans, and it will be demonstrated that the study of behavior is a necessary prerequisite for the behaviorally relevant studies of the nervous functions.

The insect nervous system makes it easy to carry out ablation experiments. The rather small number, and often the size of the nerve cells allows the study of structure and function in identified neurons or neuron assemblies. This will be demonstrated in two fields of insect neuroethology covering the organization and control of complex motor programmes, and the processing of behaviorally relevant stimuli.

Closing Plenary Lecture

APPLIED ENTOMOLOGY IN ASIA: PRESENT AND FUTURE

M. D. Pathak (The Int. Rice Res. Inst., P.O. Box 933, Manila, Phil.)

The primary emphasis in this paper will be on agricultural entomology whose applied aspects have developed in close association with the general economic conditions, agricultural productivity, and availability of qualified personnel in different Asian countries. In Japan, like other developed countries, applied entomology has been intensively investigated and practiced with heavy emphasis on pesticides. In many other countries little work on applied entomology was done primarily because of lack of scientific personnel,appropriate research organizations and low crop productivity (where even high percentage of crop loss mean only small absolute losses per hectare). In these areas where often farmers could not afford cash inputs, cultural practices and other methods received greater attention. However, pesticides were accepted readily wherever their use was found highly economical.

There has been a remarkable progress in applied entomology in most Asian countries during the last 10-15 years with the increasing agricultural productivity brought about by modern varieties and technology, and with the availability of larger number of qualified entomologists.

Fortunately, this period has also coincided with the general awareness of the limitations of use of any single method of pest control, so a balanced approach using different methods of pest control is generally being developed and followed in different countries.

Section 1.

Systematics and Evolutionary Entomology.

1S-1,1 SYSTEMATIC ENTOMOLOGY AT THE BRITISH MUSEUM (NATURAL HISTORY) AND THE SMITHSONIAN INSTITUTION--A HISTORY. Davis, D. (Dept. Ent., Smithsonian Inst., Wash., D. C. 20560, USA)

The year 1881 witnessed the founding of both the British Museum of Natural History and the Department of Entomology of the Smithsonian Institution. Growing at a present combined rate of over 700,000 specimens each year, the collections established within these two global centers of entomological research now total approximately 50 million specimens, including the primary types of nearly one half of the terrestrial arthropods known. After nearly a century of progress, the research carried on at the British Museum and the Smithsonian Institution has come to typify the latest advances in systematic entomology. To review a few of these major advances, a panel of speakers representing the principal staffs working at both museums will present summaries of our current research interests.

1S-1,2 SPECIES CONCEPTS IN DANAID BUTTERFLIES. Vane-Wright, R.I. and Ackery, P.R. (Dept.Ent., Brit.Mus.(Nat.Hist.), London SW7 5BD, UK.)

In 1880 the influence of evolutionary theory was beginning to be reflected in the taxonomy of danaid butterflies, then considered to include 210 species. By 1910, 260 species with almost innumerable subspecies were recognised. A dramatic change occurred in the early 1940s, when P.S. Corbet and G. Talbot, working at the British Museum (Natural History), literally halved the number of species, their reevaluation being based largely on characters of the male genitalia. In 1975 the present authors undertook a phylogenetic study and now recognise some 150 species. During the last 100 years the number of danaids has changed due to the successive and overlapping application of typological, polytypic and biological species concepts. This historical development is reviewed, and further changes now caused by the application of phylogenetic studies to these highly polytypic insects will be discussed.

1S-1,3 BIOSYSTEMATICS OF DIPTERA, WITH PARTICULAR REFERENCE TO IMMATURE STAGES. Cranston, P.S. (Dept. Ent., B.M.(N.H.), Cromwell Rd., London, U.K.)

The growth in awareness of the value of biological information to systematic studies is illustrated with reference to F. Walker (1809 - 1874) through F. W. Edwards (1888 - 1940) to contemporary dipterists in the British Museum (Natural History). The importance of the immature stages is exemplified in the Nematocera, particularly the ecologically important Chironomidae, and the medically important biting Culicidae and Simuliidae. The origin of incongruent classification between larvae and adult, and the continuing resolution of the problem, is illustrated in the Chironomidae.

It is argued that a 'natural' classification should use larval, pupal, adult male and female characters, and that those classifications based upon characters of a single stage are 'special' classifications, restricted in their use. Similarly, phylogenetic studies are more soundly based when incorporating information from all life history stages.

Despite the problems inherent in collecting the necessary biological data in a Museum, the historic collections and taxonomic expertise, a necessity for biosystematic studies, make a Museum a suitable institution for such studies.

1S-1,4 COMPUTER TECHNOLOGY AND APPLICATIONS IN SYSTEMATICS. Krombein, K. V. (Dept. Ent., Smithsonian Inst., Washington, D. C., 20560, U. S. A.

Specialists in Washington on the combined staffs of the Smithsonian Institution's Department of Entomology and the Systematic Entomology Laboratory, U. S. Department of Agriculture, have a number of projects using computer technology. The projects are in various stages ranging from preliminary planning to actual completion. They fall into two major categories, species or specimen inventories, and catalogs of major orders of insects. Examples of the former category are a projected specimen inventory of some 100,000 holotypes in the national collection, a completed inventory of ticks in the Rocky Mt.Laboratory, and a projected inventory of the tremendous mosquito collection in the Smithsonian. Four fascicles of one family each have been published in A Catalog of Coleoptera of America North of Mexico; other families are in preparation. The hymenopterists published in 1979-80 a complete Catalog of Hymenoptera in America North of Mexico in three volumes of 2735 pages.

1S-1,5 CYTOLOGY AND MORPHOMETRICS IN APHID SYSTEMATICS.
Blackman, R.L. (Dept. Ent., British Museum (Nat. Hist.), London SW7 5BD, UK)

Morphometric characters are widely used in aphid species-level taxonomy, but the ranges of characters frequently overlap between what appear to be good biological species, because size and allometry are greatly influenced by environmental factors such as season and host plant. Multivariate methods can sometimes be used in conjunction with simple differences of karyotype to provide firm data for species separation which may be of economic significance, as in the case of aphids of the genus Amphorophora feeding on Rubus. Karyological studies can also aid the taxonomic interpretation of aphid species complexes, in which one or more taxa are commonly agamic due to loss of the sexual phase.

1S-1,6 FUNCTIONAL MORPHOLOGY & PHYLOGENETICS IN A MAJOR MUSEUM. **Hammond**, P.M. (Dep.Ent., Brit. Mus.(Nat.Hist.), London SW7 5BD, UK.)

Much of the potential value to systematics of a major insect collection may be exploited by means of comparative morphological studies. An "holistic" approach to systematics (i.e. taking into account all aspects of the biology of organisms studied) is helpful in such studies, directing the investigator towards fruitful topics - those likely to generate broad but testable hypotheses. The investigation of functionally linked suites of morphological characters is also to be recommended. In this way, developments associated with successful adaptive radiations may be identified. In practice, through a process of "reciprocal illumination" comparative studies of function and the erection of cladistic hypotheses will go hand in hand, and often proceed simultaneously. This approach to phylogenetics is illustrated by recent work on beetles at the BMNH, including the functional morphology of structures concerned in mating and in flight-wing protection.

1S-1,7 Flower flies and Zoogeography (THOMPSON, F. C.)

Distribution patterns have intrigued biologists almost as long as those of diversity. Distrubtion patterns were used by Darwin to support his theory of evolution, but, with Wallace and subsequent workers, these patterns themselves were overlooked as attention was shifted to the study of dispersal. The geography of the world was accepted as stable, and dispersal was invoked to explain disjunctions. The advent of plate tectonics and phylogenetics (cladistics) has renewed interested in distribution patterns. Distributions of individual monophyletic taxa can be accumulated or summed to form general patterns. The coincidence of these patterns with those from other disciplines such as geology may require explanations other than dispersal over stable continental configurations. Distribution patterns of flower flies are used to illustrate some of the new concepts in zoogeography and to suggest a scenario of life for the last 180 million years.

1S-2,8 FOSSILS AND THE ORIGIN OF INSECT FLIGHT AND METAMOPRHOSIS. Kukalova-Peck, J.

(Department of Geology, Carleton University, Ottawa, Ontario KIS 5B6, Canada)

In contrast to modern pterygote nymphs, Paleozoic nymphs primitively had articulated and freely movable wings on the thorax (serially homologous with smaller wing-like abdominal appendages). This is reflected in early instars of some modern nymphs; their wing buds evaginate from the pleural region and only later become immobilized and secondarily fused with the terga. Thus, wings are modified pleural appendages. Primitive Paleozoic nymphs had a confluent development, without a metamorphic instar. This occured later, to restore the movability of the wings. Metamorphosis is polyphyletic and developed in parallel in all major insect lineages. Paleoptera and Neoptera are sister groups which diverged mainly in wing-articulatory mechanism, but before flight was fully developed. Wing appendages in (unknown) ancestral pterygotes were probably situated laterally and were incapable of being flexed backwards over the abdomen. The major groups of pterygote orders were also formed very early, probably simultaneously with the flight adaptations of the proto-wings.

1S-2,9 Origin and main-lines of evolution of insect wings as flight organs.

Bocharova-Messner, O. M.

1S-2,10

HOMOLOGIES IN INSECTS AT THE ULTRASTRUCTURAL LEVEL. Carlson, S. D. and Chi, Che. Dept. Ent. Univ. of Wisconsin, Madison, WI. 53706

The evolutionary lineage of arthropods is a fundamental issue. It is understood that the evolution of arthropod photoreceptors has a bearing on the better delineation of arthropod phylogeny. Recently Eakin (1979) pointed to the receptor molecule, rhodopsin as the basic "thread of continuity" in photoreceptor membranes. We have initiated an extensive ultrastructureal survey of the insect (housefly) photoreceptor membrane with freeze fracture and thin section technique using conventional electron microscopy (Chi, 1976, Chi and Carlson, 1979, Carlson and Chi, 1979, Chi, Carlson and St. Marie, 1979, Chi and Carlson 1980a,b) and high voltage electron microscopy (Chi and Carlson, 1976). Specifically we are concerned with the visualization of rhodopsin molecules arrayed in the rhabdomeric microvilli as well as the globular membrane proteins in unmodified plasma membranes. The latter are the intramembranal manifestations of particular cell to cell junctional specializations. These membrane characters and those of other organelles in the photoreceptor cells are compared with ultrastructural data from other workers based on several arthropods: crayfish, ant, ambrosia beetle and honeybee. We make an initial attempt to homologize the receptor proteins, membrane specializations and organelles where sufficient data permits. Common fundamental structural plans are sketched irrespective of the associated functions. We are also cognizant of developmental similarities and receptor interrelationships with adjacent glial cells in setting forth these homologies. Ultrastructural knowledge can be useful in making first assumptions about homologies/synapomorphies of receptor molecules and various retinular cell organelles as we note insect and crustacean examples. One ultimate value in any such assay is to bring additional characters to the systematist. In the case of rhodopsin, there is a sense of particular satisfaction in visualizing this miniscule structure for this compound is both the structural and functional protein of the photoreceptor cell. Structure and function have merged at this level of exploration. Supported by N.I.H. grant EYO 1686 and Hatch 2100.

1S-2,11

HOMOLOGY OF INSECT SENSILLA. McIver, S. B., Dep. Microbiol. & Parasitol., Univ. Toronto, Canada

Increasingly sophisticated transmission and scanning electron microscopic techniques permit ever more refined descriptions of sensillar structure. The contributions of recent studies to our understanding of insect sensilla will be discussed.

Introduction: 1.definition of homology, 2.criteria for establishing probability of homology and analog, 3.pros and cons electron microscopy in determination of the probability of homology

Homology of Sensillar Types: 1.Discussion of recent ultrastructural and ontogenetical evidence which supports the concept of the homology of sensory hairs, campaniform sensilla, and scolopidia. 2.Discussion of evidence from genetic studies for homology of various sensillar types with comments on the applicability of EM techniques at the molecular level.

Functional Changes of Homologous Sensilla: 1.mechanosensilla, 2.chemosensilla

Sensillar Homology and Phylogeny and Systematics: 1.summary of status of knowledge and potential significance, 2.discussion of a few excellent works*

Summary and Recommendations for Areas of Future Endeavor

*Meinecke, C.C. 1975. Zoomorphologie 82:1-42. Walther, J.R. 1979. Z. f. zool. Systematik u. Evolutionsforschung 17:30-56. Craig, D.A. and A. Borkent. In Preparation.

1S-2,12

THE EVOLUTIONARY SIGNIFICANCE OF BUTTERFLY POLYPHENISMS. Shapiro, A.M. (Dept. Zool., Univ. of Calif., Davis, Calif. 95616, U.S.A.)

Butterfly polyphenism have been studied from evolutionary, genetic, physiological and ecological standpoints for over a century, but some fundamental problems remain. In only a handful of cases has the adaptive value of the variation been established even weakly. The relationship of polyphenism to phenocopy phenomena is important for understanding their evolution, and may bear on punctuational *vs*. gradualistic models of evolution. The applicability of Waddington's concepts of canalization and genetic assimilation to such phenomena is discussed, and an experimental framework presented for testing the selective significance of environmental thresholds for the expression of genes controlling Lepidopteran color and pattern characters. Finally, the utility of polyphenism in biogeographic and phylogenetic reconstruction is discussed, using examples drawn from the Pieridae.

1S-2,13 On the origin of wings.
Matsuda, R.

1S-3,14 EVOLUTION AND DISTRIBUTION OF INSECTS IN ASIA AND THE PACIFIC AREA: INTRODUCTION.

Gressitt, J.L. (Bishop Museum, Box 19000-A, Honolulu, Hawaii 96819; Wau Ecology Inst., Wau, Papua N.G.)

The oceanic islands of the Pacific in great part have separate more or less unique insects faunas locally evolved from ancestors which have successfully colonized at rare intervals on dispersing across wide tracts of ocean. Islands more distant from source areas have less harmonic faunas, of fewer families and genera, often with great range of form among descendents of a single ancestor. Islands nearer to the source areas have more evolutionary lines represented, and many diverge less from the continental relatives. Source areas for much of the oceanic fauna are the SE (and E) Asian fringes and continental islands. The Oriental fauna spreads eastward through the Malesian archipelago and eastward of Wallace's Line there is more Australian and trans-Antarctic (Gondwanan) influence. However, contrary to the situation in terrestrial mammals, the insect fauna of the New Guinea area (Papuan Subregion) is largely Oriental. Some of the Australian elements are restricted to Australian type of savanna woodland in SE coastal areas of New Guinea with seasonal climate, just as some Papuan fauna occurs in rainforest pockets in NE Queensland. Most of New Guinea is covered with rainforest, which is primarily inhabited by insects of Oriental relationships. There is a great deal in common between New Guinea and the Philippines, either through Sulawesi or skipping it. In this sense New Guinea and the Philippines belong to an enlarged "Wallacea" which belongs much more to the Oriental Region than to the Australian. Much of this Oriental Papuan fauna evolved during the past 10 million years from colonizers from SE Asia after New Guinea was pushed up, largely in the Miocene and Pliocene, by the drifting of the Australian tectonic plate against the Pacific plate. The Papuan fauna is proving remarkably rich and diverse as more groups of insects are studied.

1S-3,15 THE ECOLOGY AND EVOLUTION OF SOME FLOWER-BREEDING DROSOPHILIDAE OF NEW GUINEA. Carson, H. (Univ. Hawaii, Honolulu 96822) and Okada, T.

Part 1. (H. Carson) Species associated with the inflorescences of Alocasia and Colocasia (Araceae). Of fourteen species of Drosophilidae associated with three species of Alocasia all but two are referred to Drosophila (Scaptodrosophila). Colocasia harbors two species of Drosophilella and one of Styloptera. Selected life cycles are given in detail. Part 2. (T. Okada) Synhospitalic evolution of Drosophilella species. A taximetrical analysis is made on the phyletic relationships of Drosophilella species in Taiwan (and Okinawa) and New Guinea. At the Taiwan-Okinawa locality, two species of this genus are found synhospitalically breeding in Alocasia flowers. Two specifically distinct but ecologically very similar species are found in Colocasia in New Guinea.

1S-3,16 HAWAIIAN CAVE INSECTS: SOME BIOCLIMATIC AND GEOLOGIC FACTORS GOVERNING THEIR EVOLUTION AND DISTRIBUTION.

Howarth, F.G. (Entomology Dept., B.P. Bishop Museum, P.O. Box 19000-A, Honolulu, HI 96819)

Highly specialized obligatory cave arthropods (troglobites) live in the relatively young lava tubes in the Hawaiian Islands. They evolved from representatives of the speciating native fauna by the process of adaptive shifts much like other animals have adapted to exploit novel habitats. Many Hawaiian troglobites have preadapted close relatives still extant and are not relicts. The deep cave zone is seen as a rigorous or harsh environment that is perpetually dark, with a relatively constant temperature, with a water-saturated atmosphere, and without many of the temporal environmental cues used by the surface species. Also, the ecosystem often appears food limited. Only a few native animals were preadapted to exploit it. The most critical environmental factor determining the distribution of troglobites within inhabitable caves is the stable saturated atmosphere. Young basaltic lava has numerous voids such as vesicles, fissures, layers, and smaller tubes which allow intercave and interlava flow dispersal of troglobites. In fact, the largest populations of troglobites are believed to inhabit these voids, and only where food and environment allow, do they enter and colonize the larger cave passages.

1S-3,18 BIOGEOGRAPHY OF THE PACIFIC EUPITHECIA GEOMETRIDS AND THE EVOLUTION OF PREDATION IN HAWAIIAN CATERPILLARS.

Montgomery,Steven L.(Dept.Ent.,Univ.Hawaii,Honolulu,HI,USA 96822.

The Eupithecia,commonly known as the pug moths,are one of the largest and most widespread genera in the family Geometridae.In addition to being well represented in every faunal region,these moths have colonized even the most remote archipelagoes.The larvae,including Hawaii's E.monticolens,are predominantly flower or seed feeders,thus it was quite unexpected to discover E.orichloris(Meyrick) is strictly an ambush predator.The caterpillar uses a foraging strategy unique for Lepidoptera by perching tightly along leaf edges until a passing insect touches its posterior abdomen.Suddenly, the inchworm strikes backwards,seizing and lifting the prey with elongate legs bearing enlarged, spinelike setae and sharp tarsal claws.Lab and field studies proved that all larval instars are completely carnivorous and rely solely upon tactile stimuli to release the 1/12 second strike.Continued collecting has revealed similar behaviors and structures for the inchworms of 7 other endemic Eupithecia,including lineages of cognate species on differing perch sites (leaf,twig,fern rachis,or ground litter).They are quite sedentary,but E.staurophragma often moves into hiding at sunrise. The adaptive radiation of predatory species has made a subgroup morphologically quite distinct from the herbivorous monticolens,but they show no closer extra-Hawaii relationships.With the caveat that some insular faunas remain little known,Ipropose that the orichloris species complex is an early autochthonous offshoot from monticolans'ancestor.Previous workers have suggested a north Asia or west Pacific derivation for Eupithecia of the Hawaiian Islands based on adult morphologies.

1S-3,19 SPECIES DYNAMICS IN RELATION TO MYCOPHAGOUS THYSANOPTERA OF THE ORIENTAL REGION

Ananthakrishnan, T.N. (Zool. Surv. India, 34, C.R. Ave, Calcutta-700012, India)

The occurrence of a wide range of phenotypes in several mycophagous thrips species has necessitated an analysis of the patterns of diversity in such species, so that, in assessing the increasing rates of complexity associated with such diversity, it has become possible to outline the extent of stability of the genotype in relation to those species, where a comparative degree of stability has been achieved through considerable restriction of the limits of deversity. From the simplest instances of expressions of such diversities as in the species of Azaleothrips Ananthakrishnan, Strepterothrips Hood, etc., through moderate expressions of visible diversity as in species of Hoplandothrips Hood, to the large scale expression of intra specific diversity as in species of Ecacanthothrips, Mecynothrips, Tiarothrips, Dinothrips, Nesothrips, etc., sufficient evidence has been presented to pinpoint the dynamics of the conocerned species. Stability in terms of an almost total restriction of intra-specific diversity is evident in species of Meiothrips and an interesting instance of restriction of such diversities only to some of the terminal abdominal segments is evident in species of Bactrothrips. Taking into consideration that species are genetic systems and that a wide range of phenotypes often result due to interaction of genes during development, an overall assessment of the degree of plasticity of different mycophagous species has been attempted.

1S-3,20

BIOSYSTEMATIC STUDIES OF CEYLONESE WASPS. Krombein, K. V. (Dept. Ent., Smithsonian Inst., Washington, D. C., 20560, U. S. A.

Intensive collecting and life history studies were undertaken in Sri Lanka during the past decade under the auspices of the Smithsonian's program, "Biosystematic Studies of the Insects of Ceylon." Revisionary studies of five families or lesser hierarchies of wasps have shown that anywhere from 17 to 100% of the taxa are new species or subspecies. The lower percentages apply to groups with larger showy species and the higher to groups of small inconspicuous species occupying obscure ecological niches. Endemism in the five groups ranges from 0 to 100%. To some extent the higher rates of endemism occur in groups of limited dispersal in which females are flightless. Much more thorough collecting in South India probably would reduce the rates of endemism in other groups. A few taxa in Sri Lanka are widely distributed in the Oriental Region, and more occur elsewhere only in the Indian subcontinent; the endemic taxa are closely related to other Oriental taxa.

1S-3,21

Zoogeography and ecology of the Ryukyu Archipelago, with special reference to the Chrysomelidae (Coleoptera). Kimoto, S. (Biol. Lab., School of Medicine, Kurume Univ., Kurume, 830 Japan).

Based on the distribution of certain groups of insects, zoogeography and ecology of the Ryukyu Archipelago are discussed.

1) The butterfly fauna of Japan and Ryukyu Archipelago is classified into four major types, viz. a) Hokkaido, b) Northeast and Central Honshu, c) Western Japanese and d) Ryukyu types, based on the faunal similarity. Among these four types, the Ryukyu type is the most isolated.

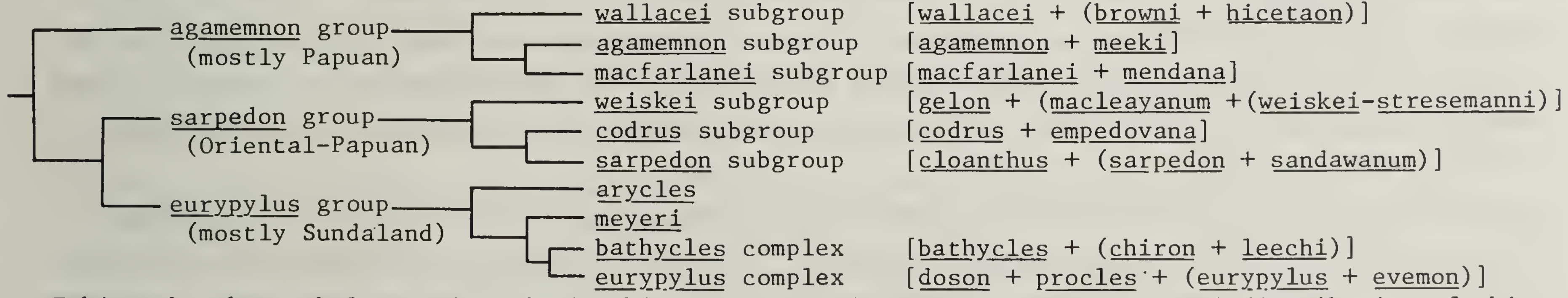
2) Islands of the Ryukyu Archipelago are classified into three faunal groups, viz. a) Yakushima, b) Amami-Oshima and Okinawa, and c) Ishigaki and Iriomote groups.

3) Aread diversity curve indicates the high species diversity in the islands of subtropical zone comparing with that of temperate zone.

1S-3,22

PHYLOGENY AND GEOGRAPHICAL DISTRIBUTION OF THE SUBGENUS *GRAPHIUM* SCOPOLI (LEPIDOPTERA, PAPILIONIDAE, GENUS *GRAPHIUM*) Saigusa, T. (Biol. Lab., Coll. General Educ., Kyushu Univ., Fukuoka, 810 Japan)

The intrasubgeneric phylogenetic relationships of the Indo-Australian subgenus *Graphium* are analyzed based on the integumental morphology with Hennig's principle of phylogenetic systematics as follows.


agamemnon group
(mostly Papuan)
sarpedon group
(Oriental-Papuan)
eurypylus group
(mostly Sundaland)
wallacei subgroup [wallacei + (browni + hicetaon)]
agamemnon subgroup [agamemnon + meeki]
macfarlanei subgroup [macfarlanei + mendana]
weiskei subgroup [gelon + (macleayanum +(weiskei-stresemanni)]
codrus subgroup [codrus + empedovana]
sarpedon subgroup [cloanthus + (sarpedon + sandawanum)]
arycles
meyeri
bathycles complex [bathycles + (chiron + leechi)]
eurypylus complex [doson + procles + (eurypylus + evemon)]

Taking the above phylogenetic relationships into consideration, the geographical distribution of this subgenus is interpreted as follows. (1) In *wallacei*-, *macfarlanei*-, *weiskei*-, and *codrus*-subgroups, sister species of each group show so distinct allopatric distribution that sister species seem to be differentiated allopatrically. (2) Although distributional ranges of most species of the *eurypylus* group widely overlap with each other in Sundaland, the speciation in this group is inferred to be allopatric because the group is relatively primitive one and distinctive subspeciation is recognized for most species. (3) Extremely wide range of each one species of 3 groups, *agamemnon*, *sarpedon* and *eurypylus*, is supposed to be attained by the expansion of the original range at the time point of speciation.

1S-3,23

ORIGIN AND DISPERSAL OF TRECHINE BEETLES IN EAST ASIA. Uéno, S.-I. (Dept. Zool., Natn. Sci. Mus. (Nat. Hist.), Shinjuku, Tokyo 160, Japan)

About 280 species of trechine beetles have hitherto been found in East Asia. They are roughly divided into two groups, northern and southern, regardless of their phylogenetic relationship, though they are classified into 35 genera. The trechines of the northern group do not extend their distribution to the southern areas of East Asia. Their native place is not apparent, but is presumed to have been somewhere in the Far East, seeing that they are most variable in the areas bordering on the Sea of Japan and that the most primitive forms also occur here. Their northern distribution as seen to-day may have been formed secondarily after the Glacial Period, though our knowledge is still inadequate to go into further discussion on this subject. As compared with the northern one, the southern group is more widely distributed in East Asia. The largest taxonomic group showing the southern type of distribution is that of *Trechiama*, which comprises about 180 species of 15 genera and exhibits the most intensive differentiation in Japan, though its representatives occur also in the Soviet Far East, Korea, Taiwan and East China. A careful analysis of their distributional pattern suggests that the group may have originated in the Chinese Continent, in spite of the fact that only one species of this group has hitherto been found there. Other taxonomic groups, which include the so-called Himalayan elements, are also considered to have arisen in China. Thus, about 200 species distributed to 24 genera, or about 70% of genera and species of all the known trechine beetles occurring in East Asia, seem to have originated in the Chinese Continent and radiated from there.

1S-4,24

SPECIATION IN THE *ENCHENOPA BINOTATA* COMPLEX (HOMOPTERA:MEMBRACIDAE). Wood, Thomas K., and Guttman, S. (Dept. Ent., Univ. Delaware, Newark, DE., U.S.A.)

The membracid *Enchenopa binotata* Say, was considered a single species occurring on 6 sympatric host plants. Over the last 10 years we have shown considerable biological variation in insects related to their native host. Host and mate selection experiments supported by isoenzyme studies showed *E. binotata* to be a complex of reproductively isolated species.

Divergence appears to have been initiated through the coordination of egg hatch with host plant phenology producing allochronic life histories. Allochronic flight, mating and male mortality combined with low vagility promoted assortative mating along host plant lines. Such assortative mating and discontinuous plant distributions suggests the divergence of this complex occurred in sympatry.

1S-4,25

ALLOPATRIC AND SYMPATRIC SPECIATIONS IN THE GENUS *HEMITAXONUS* (HYMENOPTERA: SYMPHYTA). Naito, T. (Ent. Lab., Fac. Agr., Kobe Univ., Kobe, 657 Japan)

The genus *Hemitaxonus* is a small group of sawflies associated with various ferns. Twelve old world species are concentrated in Japan and adjacent areas. Adult features are relatively uniform, but the species clearly differ from each other in their host plants. Four species groups are recognized, each somewhat distinctive in morphological, biological, and cytological characteristics, and each group includes sibling species.

There seems to be two different modes of speciation in *Hemitaxonus* based on studies of the sibling species. One is allopatric speciation which results from a host shift on the periphery of the species distribution when the species spreads beyond the distributional range of the old host plant. The other is sympatric speciation which caused by host diversion within the body of species populations. Biological attributes of these sawflies such as strict host specificity, critical synchronization with host appearance, and especially mating on the host fern may play an important role in the speciation process. There is no evidence that geographical barriers are a primary prerequisite for speciation in these sawflies.

1S-4,26

ANALYSIS OF SPECIATION BASED ON SEASONAL CHARACTERISTICS.

Tauber, Catherine A. and Tauber, Maurice J. (Dept. Ent., Cornell Univ., Ithaca, New York, 14853, U.S.A.)

We propose that sympatric speciation can occur through two alternative mechanisms. First, sympatric speciation is a process limited to isolated speciation events followed by range extension of the new species. In such cases, sympatric populations of the sibling species are expected to share relatively few homologous locally-adaptive seasonal characteristics.

Second, sympatric speciation occurs over wide geographic areas by means of gene flow through geographically diversified populations of the parental species. In this case, local populations of the derived sibling species share many homologous locally-adaptive characteristics.

1S-4,27

GEOGRAPHICAL DISTRIBUTION AND SPECIATION IN *HENOSEPILACHNA VIGINTIOCTOMACULATA* COMPLEX (COLEOPTERA, COCCINELLIDAE).

Yasutomi, K. (Dept. Ent., National Institute of Health, Tokyo, 141 Japan)

Henosepilachna vigintioctomaculata complex is divided into two main groups, one being *H. vigintioctomaculata* (potato feeder) and the other *H. pustulosa* (thistle feeder), together with questionable forms, Tokyo west-suburb epilachna (potato feeder) and Towada epilachna (*Caulophyllum* feeder). The present report mainly deals with the studies on the morphology, geographical distribution, host preference and phylogenetical relationship in this complex. The marking patterns of larvae and pupae in *H. pustulosa* varies greatly according to locality. The pattern type of Tokyo west-suburb epilachna is closely related with that of the Towada epilachna, differing far from that of *H. pustulosa* and of *H. vigintioctomaculata*. The recent results suggest that the form differentiation in two major groups of the complex occurred at different periods.

1S-4,28

CLIMATIC "HOST RACE" FORMATION IN *HENOSEPILACHNA VIGINTIOCTOMACULATA* COMPLEX, A SIBLING GROUP OF PHYTOPHAGOUS LADYBIRDS (COCCINELLIDAE: COLEOPTERA)

Hoshikawa, K. (The Inst. of Low Temp. Science, Hokkaido Univ., Sapporo, 060, Japan)

Several closely allied species of Epilachninae occur in Japan, varying in morphology and food habits, being divided into two main groups. One consists of a single species, *H. 28-maculata*, distributed in Eastern Asia. The other is endemic to Japan and considered to be diversified there, involving several races or species. Their food preferences vary geographically, including some clines.
An analysis on the mechanism of cline formation proved that relative food shortage, in relation to bionomic discordance between insects and plants, is a cause of niche expansion. This discordance seems to be brought by the discrepancy of climatic adaptation between insects and plants. Moving zone of the food shortage divides a race into two host races, as a wedge on adaptation to the host plant. In reference to Quaternary climatic change, phylogenetic relations of these host races could be interpreted by geographic variations in food preference.

1S-4,29 ROLE OF REPETITIVE AND UNIQUE DNA SEQUENCES IN SPECIATION. White, M.J.D. (Dept. Pop. Biol., Aust. Nat. Univ., Canberra, A.C.T. 2601 Australia)

The paper will discuss the relative roles of changes in structural genes, in the moderately repetitive and highly repetitive DNA's, and in the organization of the karyotype in generating genetic isolating mechanisms and regulatory changes affecting developmental patterns.

1S-5,30 ADAPTATIONS, ECOLOGICAL DIVERSIFICATIONS, AND THE ORIGIN OF HIGHER TAXA OF SEMIAQUATIC BUGS (GERROMORPHA). Andersen, N.M. (Zoological Museum, Univ. Copenhagen, DK-2100 Denmark).

A cladogram of relationships between the eight families of semiaquatic bugs is presented. A number of adaptive features are discussed and their ancestral and derived states separated. There have been several evolutionary transitions between locomotion on the surface film by walking and by rowing or leaping. Two different kinds of predator strategies can be distinguished: that of a searching predator and that of a waiting predator utilizing surface disturbances in prey-location, which is the most derived. Wing polymorphism, sexual behaviour, and diversification of the egg system are also discussed. The ancestral type of habitat of most gerromorphan families was humid terrestrial and/or marginal aquatic. Derived habitats include the plant-covered water surface, the free surface of fresh water, stagnant or flowing, intertidal marine waters, and the open sea. The evolutionary diversification of semiaquatic bugs is visualized as a repeated series of transitions between a hygropetric and a pleustonic adaptive zone and adaptive radiation towards various subzones of the latter. Such transitions have not always been associated with the origin of higher taxa.

1S-5,31 THE PHYLOGENY OF THE LEPTOPODOMORPHA AND ITS RELATIONSHIP TO OTHER HETEROPTERA.

Polhemus, John T. (Martin Marietta Corp., P.O. Box 179, Denver, Colorado 80201 U.S.A.)

A phylogeny based on shared derived characters divides the Leptopodomorpha into three major sections, the Saldoidea, Omaniidae and leptopodoidea. In this phylogeny, Aepophilidae is treated as a monotypic family, Leotichidae and Leptosaldinae are included in the Leptopodidae, and Omaniidae is more closely allied to the Leptopodidae than the Saldidae where it was formerly included. This parsimonious scheme, with little or no homoplasy, has good predictive value and the ability to accomodate some recently discovered high level taxa. In the proposed phylogeny a well developed female ovipositor and thickened antennae must be considered primitive. The polarity of these and other characters must be tested on other bases. The relationship of the Leptopodomorpha to the Dipsocoromorpha, Gerromorpha and Nepomorpha must be examined on the basis of shared derived characters.

1S-5,32 The higher classification of Cimicoidea.

Caroyon, J.

1S-5,33 AN ESTIMATION OF THE GROSS STRUCTURE OF HEART FOR THE HIGHER CLASSIFICATION OF THE HETEROPTERA.

Miyamoto, S. (Chikushi Jogakuen Jun. Coll., Dazaifu, Fukuoka Pref., 818-01 Japan)

The heart of the Cryptocerata is elongate and extending throughout all or most of the abdomen but that of the Gymnocerata is much shortened and restricted within a few posterior segments of abdomen (Hinks, 1966). Correlated with shortening of the heart, numbers of the aliform muscles and of ostia should be reduced, but these might be occurred rather independently in each group of the Gymnocerata. Originating points of aliform muscles are all tergal in the Cryptocerata, but a few hinder pairs of them become sternal in the Gymnocerata. In the latter division, AM_6 (aliform muscles originating from the 6th abdominal segment) and AM_7 in the Gerromorpha and AM_7 in the Cimicomorpha are arising near outer margins of sternum. Originating points of AM_7 on the sternum are shifted inwards in the Reduviidae, Saldidae and the Pentatomomorpha. Further, three these groups may be separated by the structure of AM and others.

1S-5,34 THE PHYLOGENETIC SIGNIFICANCE OF THE EXTERNAL STRUCTURE OF THE ABDOMEN IN THE HEMIPTERA.

Sweet, M.H. (Depts. Biol., and Ent., Texas A&M Univ., College Station, Tx, USA)

The plesiomorphic condition is considered to be as in the auchenorrhynchous Homoptera: on segments 2 to 7, terga and sterna are free, with intersegmental conjunctivae present, and a set of spiracle-bearing paratergites are present. Sternum one is apparently absent, tergum one inflexibly joined to tergum 2, and spiracle one dorsal at anterior lateral margin of segment one. In Homoptera the tergum is enlarged, arched and the sternum small; in Heteroptera, the converse. In Heteroptera dorsal and ventral laterotergites are present, forming the connexivum.

In Heteroptera evolutionary trends are 1) joining of segmental sclerites and loss of conjunctivae and longitudinal muscles, 2) joining of ventral spiracle-bearing connexival sclerites with sterna, 3) longitudinal conjuctivae developing between terga and connexiva, which permits expansion, 4) in trichophorous Pentatomomorpha, the connexivum is evidently turned over, the ventral laterotergite becoming the evident dorsal connexivum, and the dorsal laterotergite becoming the inner or internal laterotergites. This morphological shift may account for the flexibility in spiracle position in the lygaeoid families.

1S-5,35 ADAPTIVE ZONES AND THE HIGHER CATEGORIES OF HETEROPTERA (HEMIPTERA). Schaefer, Carl W. (Biol. Sciences Group, Univ. Conn., Storrs, Conn. 06268, USA)

One may often generalize on the biology and world distribution of the members of major (family-group) taxonomic categories. From such generalizations come ideas about the adaptive zone into which the population ancestral to the family-group entered, to which that population became adapted, and in which it radiated. Interesting in themselves, these ideas also help in the establishing of phylogenies.

I discuss such generalizations and ideas with respect to the major groups of Heteroptera, empasizing the land bugs ("Geocorisae"), especially the trichophoran superfamilies and families.

1S-5,36 SOME REFLECTIONS ON RECENT AND FUTURE PHYLOGENETIC STUDIES IN HETEROPTERA.

Cobben, R.H. (Laboratory of Entomology, Agricultural University, Wageningen, the Netherlands).

This presentation is mostly concerned with some misconceptions arisen in literature regarding aims and procedures laid down in my books of 1968 and 1978. The inherent value of studying morphoclines is stressed. It will be shown that, in the very case of major evolution of Heteroptera, it is possible to decide safely on polarity of character changes and to trace parallelisms without some cladogenetic framework. The next step in the reconstruction of the total evolution of Heteroptera, that is inclusive of the phylogeny, must of course be achieved via cladistics. Some published cladograms of higher phylogeny of Heteroptera will be reanalized, I repeat my earlier expressed warnings against too ephemeral cladistic treatment.

1R-1,1 Fossil Coleoptera from late Pleistocene asphalt deposits of Southern California.

Peck, S. B. and Miller, S. E. Carleton University, Ottawa, Canada and Santa Barbara Museum of Natural History, Santa Barbara, California.

Asphalt impregnated sediments bearing fossils occur in several areas of thw world. The richest assemblage of late Pleistocene terrestrial vertebrates occurs in such deposits at Rancho La Brea, Los Angeles, California. With this is associated an abundant fossil insect assemblage. Radiocarbon dating indicates deposition over most the past 40,000 years. Beetles (Coleoptera) are the best preserved insects at three southern California sites, and were first studied by W. D. Pierce. Reexamination of many hundreds of specimens indicates 4 paleoecological groupings: aquatics and semiaquatics; carrion and dung feeders; ground dwellers; and plant feeders and incidentals. Modern systematic work has defined the presence of 5 silphid, 3 staphylinid, 19 tenebrionid, and 1 scarab species. Most of these species still live in or near the sites of deposition. A few have ranges displaced to the north. Extinction is known only for one scarab species. Pit 91 at Rancho La Brea has been reopened and is being excavated with careful attention to insect microfossils and stratigraphy. This should yield improved understanding of late Pleistocene insects and environments of Southern California.

1R-1,2 Some trends in evolutionary insect taxonomy

Ghilarov M.S. (Inst.Evol.Morph.Ecol. Acad.Sci.,Moscow 117071,USSR)

Modern taxonomy has both the analytical tasks (identification of insects) and synthesizing ones (elaboration of a classification based on natural hierarchy of taxa) reflecting the results of insect phylogeny). Numerous systems of insects proposed in the current century pretend to reflect their phylogenetic relationships though often the concepts of insect evolution accepted by various authors are mutually excluding. As examples may serve systems proposed by Handlirsch or by Martynov and based on other principles rather coinciding systems by Ghilarov, Mackerras, Grandi etc. The modern system especially of higher taxa must be based on data not only of morphology (including internal anatomy and karyology) but also of ecology, ethology, physiology and biochemistry.

Numerical taxonomy can be of value for analytical purposes of systematics and for checking proposed systems but not to construct a natural classification.

1R-1,3 THE HENNIGO-CLADISM: A TAXONOMIC METHOD BORN OF ENTOMOLOGY. Dupuis, C. (Muséum National d'Histoire Naturelle, 75231 Paris Cedex 05, France)

For the first time, the opportunity of an International Congress of Entomology is taken to devote a paper to the basis, achievements and promises of the "phylogenetische Systematik" of the prominent entomologist Willi Hennig (1913-1976). This taxonomical methodology, known today as "cladism", is presently in full expansion in Entomology, Ichthyology and Paleontology. The main research and propagation centers are in Scandinavia, New York (Amer. Mus. nat. Hist.), London (Brit. Mus. nat. Hist.), Stuttgart (Staatl. Mus. Naturk.) and Paris (Mus. nat. Hist. nat.) — The most recent works for further reading are: J. Cracraft & N. Eldredge (Ed.), Phylogenetic analysis and Paleontology, Columbia Univ. Pr., 1979, 233 pp. - C. Dupuis, La systématique phylogénétique de W. Hennig, Cahiers des Naturalistes, 34 (1978) 1979: 1-69 - W. Hennig, Phylogenetic Systematics, Univ. Illinois Press, 1966, 2nd printing 1979, 263 pp.

1R-2,4 PHYLOGENY AND FUNCTION IN THE CARABOIDEA (COLEOPTERA).

Evans, M.E.G. (Dept. Zoology, Manchester University, Manchester M13 9PL, U.K.)

Caraboidea can be sub-divided functionally in terms of both feeding mechanisms and head structure, and locomotor mechanisms and thoracic structure. An approach to phylogenetic problems via locomotor adaptations has proved particularly valuable. For instance, the traditional carabid subfamilies Carabinae and Harpalinae appear to embody different combinations of running and wedge-pushing abilities. Thus the basic Carabinae habit is a compromise between better running and poorer wedge-pushing (possibly the ancestral carabid habit), whilst that of the Harpalinae is between stronger wedge-pushing and slower running. The latter compromise may have originated when the Cretaceous angiosperm revolution altered forest floor conditions. Later adaptations partly obscured this simple dichotomy. Aquatic caraboids have lost the original caraboid ability of oscillatory wedge-pushing because of their immobilised metacoxae. In this they resemble the Trachypachidae, from which dytiscomorphs (excluding Haliplidae and Gyrinidae) probably originated. Why this immobilisation? Speculations upon this and other adaptations are made in the light of functional considerations and fossil evidence.

1R-2,5

FUNCTIONAL MORPHOLOGY AND PHYLOGENY OF THE SUPERFAMILY CURCULIONOIDEA (COLEOPTERA).Morimoto,k.(Ent.Lab.,Kyushu Univ.,Fukuoka,812 Japan)

The study of functional morphology is a recent approach towards understanding the phylogenetic relationships of the different shapes through the comparative study of habits of life in relation to the usefulness of the morphological characters. The studies of the Curculionoidea indicate the association of many morphological characters with special performances. For instance, in relation to the oviposition habits, the following characters are closely associated : for drilling the oviposition hole, mandibles-rostrum-head-prothorax-legs; and for the oviposition after drilling hole : ovipositor-abdomen (-hind legs). Another example is for the wood boring habits : anteriorly directed short rostrum-cylindrical body-developed unci or denticules on tibiae-concave prothorax and abdomen for the reception of legs (and also reduction of gular region, in many groups of Coleoptera of the similar habits).
The phylogeny of the Curculionoidea will be discussed along with the functional understanding of the structures.

1R-2,6

The Taxonomic value of the internal Sac in some Bruchidae (Coleoptera) of IRAQ.

H.A. Ali and A. AL-Kadhim (Dept. of Biology, College of Science Baghdad University - Baghdad - IRAQ.

The Bruchidae of IRAQ have never been the subject of aspecial study and only few species are known from faunal lists. This investigation shows that the structures of the male genital tube and specially the internal Sac are very useful in separating the closely related species. Keys and diagnosis of new species were built mainly on the differences of these structures.

1R-3,7

ADAPTATION IN HYPOGEAN HYDRADEPHAGA.*Franciscolo* M.E.(Prof.of Entom.,Genoa Univ.,Italy)

Proper research proved *Hydradephaga* are rare but widespread in aquifer(*Siettitia* Ab.1904, Richoux 1978:France;*Uvarus chappuisi* Pesch.1932:Ivory C.;*Morimotoa*,*Phreatodytidae* Uéno 1957:Japan; *Kuschelhydrus*,*Phreatodessus* Ordish 1976:N.Zealand;*Haideoporus* Young & Longl.1976:Texas)whereas troglobious ones are exceptional(*Trogloguignotus* Sanfil.1958:Venez.;*Sanfilippodytes* Franciscolo 1979:Mexico).Ten species only out of 3.800 epigean Dytiscids are known to date,sharing to various degrees eye & wing reduction,depigmentation,unusual fusion of urosterna,prosternal process leaving part of mesosternal furca exposed(as in *Vatellini*)a result(Young & Longl.1976)of biomechanical adaptation to moving in restricted spaces,long & exile peripheral & epinotal setae,directly originating from cuticle,which (concomitant with eye reduction)are suggestive of a)a short-range antipredator detector,b) a stabilizer of bottom walking in water,c)a result of still water environment. Behaviour of *Phreatodytes* and *Sanfilippodytes*,hardly capable of swimming,their bulky form & absence (or strong reduction in *Sanfilippodytes*)of crural natatorious hairs,suggest they are mainly bottom walkers.Similar behaviour was partly noticed in the terrestrial Dytiscid *Geodessus* Brancucci 1979(India,Nepal),a non-swimming,primary forest litter dweller.
Selecting pressure in specialization to hypogean life in *Hydradephaga* seems to act along pathes rather diverse from those known for troglobious terrestrial beetles, e.g.inducing loss of dytiscioid swimming & developing,through haliploid water ambulation,true bottom-walking habits.

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1R-3,10 THE REGULARITY AND THE IRREGULARITY IN THE LOCAL VARIATION OF JAPANESE BUTTERFLIES.Fujioka,T.(Fac.Eng.Keio Unv.Yokahama,223 Japan)

The distributions and the local variations of almost all Japanese butterflies are studied.There are two types in the local variations,the regular one such as cline and the irregular one to be seemed due to the random process.The differences of the wing pattern of many local forms are numerically treated and the relative oldness of the separation of local forms will be inferred from the mean of the differences.

1R-4,8 SPECIATION PROCESSES IN WINGLESS TENEBRIONIDS. Endrödy-Younga, S., Transvaal Museum, P.O. Box 413, PRETORIA, 0001, Republic of South Africa.

In the wingless Tenebrionid genus Anomalipus, comprising almost 100 taxa a particular mode of speciation was observed. Here the geographical isolation of populations is combined with polarisation of morphs elucidating the morphological changes in the process of allopatric speciation. Species, in various stages of punctuated equilibrium in the course of evolution are represented within the same genus. Monomorphic species with large distribution areas represent the conservative, stable period of specific evolution. Others with numerous geographical races of small distributions are in the stage of active speciation. It is presumed that polymorphic species without geographical polarisation of morphs represent the first step of phylogenetic activation.

1R-4,11 CHEMOSENSORY SYSTEMS AND INSECT EVOLUTION

Chapman, R.F. (COPR, London)

Orthopteroid insects possess many hundreds of sensilla on the mouthparts, while Hemipteroids and Endopterygota have relatively few although their behaviour involves equally complex chemical discrimination. The possibility is discussed that these differences reflect major steps in the evolution of the insects.

1R-4,12

PARALLEL EVOLUTION OF MOUTH PARTS AND SALIVARY CHROMOSOMES IN NEANURIDAE(COLLEMBOLA).

Lee,B.H.(Biol.Lab.,Jeonbug National Univ., Jeonju, 520 Republic of Korea)

Some neanuran members of Collembola(Insecta) were reported to show polyteny in their salivary chromosomes, related to regressive simplification of mouth parts(Cassagnau,1968). Further observations confirming this correlation and the parallelisms of both mouth parts and salivary polytene chromosomes have been obtained with Korean materials and it is considered to suggest that these evolutionary trend might occur not only in some supra-generic categories but also even at infra-generic levels.

1R-5,13

THE PRESENT STATUS OF OUR KNOWLEDGE OF THE MUTILLIDAE FAUNA OF AFRICA SOUTH OF THE SAHARA (excluding Madagascar).

Nonveiller,G.(Zemun,Yugoslavia)

The progress of the study of the paleoafrican Mutillidae evolved through several periods.They can be marked by SICHEL & RADOSZKOWSKI's Monographe of the Mutillidae of the Old World (1869;50 African species,all included in the unique genus Mutilla),by ANDRE's comprehensive survey of the Mutillidae of the world in WYTSMANN's "Genera insectorum" (1903;230 species from Africa,ranged in 15 genera) and in BISCHOFF's monographe of the Mutillidae of Africa (1920),where to the 524 species known at that time 655 new ones have been added,as well as 20 new genera to the 22 before established.At the same time,BISCHOFF created several tribes,maintained so far at different level.

The study of a numerous material collected by the author in Cameroun or received for examination from an important number of museums and private collections,and proceeding from almost all parts of the considered area,showed a lot of new data of taxonomic importance,so that a general revision of the systematics of the paleoafrican Mutillidae became necessary.Thus,in a series of generic revisions of the author, published since 1973,new genera have been established and the number of species of the examined genera has been increased at least twice as many.Further contributions are in progress.

Nevertheless,the Mutillidae fauna of the mentionned area is far to be known and systematical explorations,to be undertaken in different parts of the paleoafrican region,will undoubtedly provide considerable new data on that fauna.

1R-5,14

REVISION OF AUSTRALIAN MESOCHORINAE (HYMENOPTERA, PARASITICA, ICHNEUMONIDAE).

Short, J.R.T. (Dept. Zool., Australian Nat. Univ., Canberra, Australia)

Australian Mesochorinae have been described from one specimen of *Cidaphus* from Victoria, one specimen of *Stictopisthus* from Queensland and 7 specimens (6 ♀♀, 1 ♂) of a *Mesochorus* on a slide preparation from Western Australia. A revision of Mesochorinae on adult and larval characters has been prepared by trapping and rearing from all faunal provinces of Australia. Species of *Mesochorus* and *Stictopisthus* are widely distributed, the first as hyperparasites of chrysomelid and pergid defoliators of eucalypts. *Plectochorus* is present in Australia as in Oriental and eastern Palearctic regions. Relationships between Neotropical and Australian species groups of *Mesochorus* and *Stictopisthus* are discussed.

1R-5,15

The taxonomy and evolution of the endemic Hawaiian Chalcidoidea.

Yoshimoto, C.M. (Canadian Forestry Service, Dept. Environment, Ottawa, Ontario).

Abstract: The endemic Hawaiian Chalcidoidea consist of 5 families, 18 genera and 186 species. The subfamily Miscogasterinae of the family Pteromalidae contains 14 genera of which 10 genera represent 66 percent endemism. Six new genera are included in the classification. The family Eupelmidae contains two endemic subgenera belonging to two genera. A total of 77 endemic species are known from this family. The genus *Eupelmus* Dalman is represented by 89 species of which 86 percent are endemic, the highest percentage of endemism in a single large genus in Hawaii. On the other hand, the Hawaiian Encyrtidae is represented by 55 genera, with 4 endemic genera or 7 percent endemism. This indicates that a large number of recent immigrants are parasites on insect of economic importance. The family Eulophidae contains two genera, the genus *Necremnus* Thomson with 5 species, all in the subgenus *Pauahiana* Yoshimoto and the genus *Sympiesis* Forster with 10 species. Among the Hawaiian Mymaridae, majority of the species of *Polynema* Haliday are endemic to the Islands and the *Polynema* contains 43 species of which 78 percent are endemic. It evolved from two separate invasions of ancient immigrants and is separated into 5 species-groups.

1R-5,16

EVOLUTION AND A SUBGENERIC CLASSIFICATION OF THE BEE GENUS *PALAEORHIZA* OF NEW GUINEA. Hirashima, Y. (Ent. Lab., Kyushu University, Fukuoka, Japan)

Palaeorhiza is the only large genus of bees that is centered in New Guinea. It has a distribution similar to that of the birds of paradise. Modern classification of the genus was proposed by Michener in 1965, and a revisional work has been undertaken by me from 1975 onward. Probably it includes a few hundred species. The morphological divergence as well as color variation in this genus are incredible. Now 16 subgenera are recognized, most of which are unpublished. Among them, *Sphecogaster* is of special interest to refer to the similarity to the Sphecidae possessing the petiolate 1st abdominal segment. *Ceratorhiza* is also unique in having the conical projection on the propodeal enclosure, a feature unknown among the Apoidea. *Cnemidorhiza* and *Cercorhiza* are also noteworthy in having the modification of the hind tibiae and the pygidial plate which reflect their evolutional trend to burrow in the soil. *Callorhiza* is still a large subgenus which contains many morphologically deviating groups. The phylogeny of the Hylaeinae to which *Palaeorhiza* is belonged will also be discussed.

1R-6,17

CONSIDERATIONS ON CYTOTAXONOMY AND SPECIATION IN THE DRAGONFLY GENUS RHINOCYPHA (ODONATA: CHLOROCYPHIDAE). B. *Kiauta* and M.A.J.E. Kiauta (Dept. Anim. Cytogenet. & Cytotaxon., Univ. Utrecht, Padualaan 8, Utrecht, The Netherlands)

Along with the cytologically little-known Polythoridae, the Chlorocyphidae is the only calopterygoid family with the type number (n=12) lower than that of the Order. The taxa examined are: *R*. *biforata* *beesoni* Fr. (India), *b*. *biforata* Sel. (Thailand), *c*. *colorata* Sel. (the Philippines), *fenestrella* Ramb. (Thailand), *quadrimaculata* Sel. (India, Nepal), *trifasciata* Sel. (India), and *unimaculata* Sel. (India, Nepal). The karyotypic morphology of the genus is characterized by variation in chromosome number and TCL on intra- and interspecific levels, with or without a geographic gradient, resulting in an appreciable variation of the recombination index which, however, hardly ever reaches the calopterygoid adaptive level. - The association of low recombination potentials with the rather unique *Rhinocypha* ecology, resulting in an exceptionally low grade of interspecific competition, is tentatively assumed. The lack of cytogenetic stability suggests the present occurrence of intense evolutionary processes in the genus.

1R-6,18 THE HYBRIDIZATION BETWEEN A PAIR OF SIBLING SPECIES, *DROSOPHILA IMMIGRANS* AND *D. FORMOSANA*. Lin, F. J. (Inst. Zool., Acad. Sinica, Taipei 115, China)

The sibling species, *Drosophila immigrans* and *D. formosana*, can only be distinguished by their fine morphological structures especially in males, by the differences in the tarsus on the foreleg and in the genitalia. As for cytological analyses, no significance between brain cell karyotypes was observed. Homology of the polyteny chromosomes is existed in the whole X-chromosome, 2R-chromosome and 3-chromosome arms. As for results of sexual isolation experiments and hybridization tests, we found that complete sexual isolation between the two siblings and the phenomenon of non-interbreeding among F_2, F_3 and F_4 hybrids, although F_1 hybrid showed partial fertile. From the points mentioned above, we could be sure that both species have reached the full specific level in the process of their historical evolution. According to the zoogeographical distribution and ecological living niches, we could further deduce that the populations of *D. immigrans* and *D. formosana* have diverged from the ancient population of *D. immigrans* stem having uncertainty of sympatric or allopatric speciation process, although they are sympatric in Taiwan now.

1R-6,19

GENETICS OF SPECIATION IN *DROSOPHILA NASUTA* SUBGROUP. Krishnamurthy, N. B., Ranganath, H.A. (Dept. Zool., Univ. Mysore, Manasa Gangotri, Mysore-570 006, India).

Nasuta subgroup of the immigrans species group of *Drosophila* is an interesting assemblage of morphologically almost identical forms. It includes *D.n.nasuta*, *D.n.albomicana*, *D.n.kepulauana*, *D.kohkoa*, *D.pulaua*, *D.s.sulfurigaster*, *D.s.bilimbata*, *D.s.albostrigata*, *D.s.neonasuta*, *D.nixifrons*, *D.pallidifrons* and *D.tongpua*. These enjoy wide range of distribution and exhibit different degrees of reproductive isolation. Speciation is a dynamic process and the emergence of genetic differences and hence the reproductive isolation is a complex phenomenon. The probable mechanics of speciation in the *nasuta* subgroup will be presented in the light of interspecific hybridization, comparison of the banding patterns in the giant chromosomes and isozyme studies in the above mentioned members. The evolutionary status of these members will be discussed.

1R-6,20 INVERSION POLYMORPHISM IN THE TAXON *ANOPHELES STEPHENSI*. Miles, S. (Ross Inst., L.S.H.&T.M., Keppel St, London WC1E 7HT, U.K.)

Polymorphism for the b arrangement of chromosome arm 2, and an association between carriers of this arrangement in the homozygous standard of inverted condition and certain behavioural, physiological and morphological differences has been reported in laboratory colonies of *An. stephensi*. This polymorphism has not been detected, however, in samples from natural populations. The possibility exists that two gene pools, marked by the standard and iverted chromosome arm 2 arrangement, exist within the taxon *An. stephensi*.

1R-7,21

GENETICS OF PAPILIO LOWI. Ae, S.A., (Bio. Lab., Nanzan Univ., Showaku, Nagoya, 466 Japan)

Papilio lowi Druce is distributed in Palawan Islands and is also classified as a subspecies of P. memnon. It produced F2 females and males in lowi - memnon pryeri (Okinawa) crossings and produced females and males in backcrosses of lowi - polymnestor parinda (Sri Lanka) and lowi - rumanzovia (Philippines) crossings. Therefore, P. lowi is very closely related with these species.

1R-7,22

BIOSYSTEMATIC COMPARISON OF TWO ASIAN SIBLING SPECIES GROUPS IN COCCINELLIDAE (COLEOPTERA). Sasaji, H. (Biol. Lab., Fukui Univ., Fukui, 910 Japan)

Harmonia axyridis Pallas and H. yedoensis Takizawa are closely related and difficult to be distinguished by the adult characters, although those larvae are clearly different. The genetic polymorphisms of elytral colour patterns are quite parallel in both species. Crossing experiments showed the entire establishment of the reproductive isolation between two species. Propylea quatuordecimpunctata L. and P. japonica Thenberg are another pair of the sibling species. The hybrids between them were fertile until the third generation in laboratory, but the gene exchange does not seem to be made between natural populations. Comparing two cases of sibling species groups, the degree of reproductive isolation is stronger in the Harmonia group, but the divergence of visible characters is more distinct in the Propylea group. The results of electrophoretic study shows that two species in each group have very close affinities respectively. Informations from various biological fields are also compared.

1R-7,23

TIMING OF REPRODUCTIVE ACTIVITY IN TWO SYMPATRIC SPECIES OF WATER-STRIDERS (HETEROPTERA: GERRIDAE). Spence, J.R. and Scudder, G.G.E. (Dept. of Zoology, University of British Columbia, Vancouver, B.C., Canada)

Timing of mating and oviposition is compared between Gerris comatus and G. pingreensis by placing the activities on a physiological time scale. There are time lags between emergence from overwintering diapause and first mating, and between first mating and oviposition in both species. Reproductive activity continues throughout post-diapause life but mating is not orchestrated by courtship rituals nor are there significant post-reproductive periods in either species. Adults of G. pingreensis achieve reproductive maturity and females produce eggs more quickly than do those of G. comatus on the physiological time scale. This difference in life-cycle timing explains the earlier pulse of first instar larvae observed consistently for G. pingreensis in the field.

1R-8,24 MICROALLOPATRIC DISTRIBUTION AND HETEROCHRONICAL EMERGENCE OF THE TWO SPECIES OF THE GENUS DROSOPHILLELA BREEDING IN THE SAME FLOWERS, WITH SPECIAL REFERENCE TO ALLOMORPHOSIS OF THE WING VEINS (DROSOPHILIDAE). HONDA-YAFUSO, M. (COLL. AGR., UNIV. RYUKYUS, OKINAWA, 903-01, JAPAN)

Two new species of the Genus Drosophillela breeding in the same flowers of Alocasia odora (Araceae) are described by T. Okada (Okada 1975, 1980), named Drosophillela alocasiae and D. xenalocasiae. The larvae of alocasiae having small and numerous spicules on the body wall and short caudal spiracles, concentrated in the staminate flowers and/or transitional region. The larvae of xenalocasiae, however, having strong and sparse spicules and long and bi-forked caudal spiracles, bred among pistillate flowers, the bottom of which are frequently flooded. Comparing the number of adult flies emerged each month, heterochronical emergence were observed. The emergence peak was stronger and always later in xenalocasiae than in alocasiae. The reason why alocasiae has the early peak of emergence, seems to be that the staminate flowers in which alocasiae larvae breed wither and drop off in a short time. The wing-lengths of these two species descended from winter to summer. Burla's rule was acceptable only partly by these two species.

1R-8,25 RESOURCE EXPLOITATION BY GALL-WASPS OF THE GENUS DIPLOLEPIS (CYNIPIDAE, HYMENOPTERA). Shorthouse, J.D.

1R-9,26 CONTRIBUTION TO THE KNOWLEDGE OF THE APHIDIDAE OF MEXICO. I. - THE SPECIES OF ECONOMIC IMPORTANCE. Peña-Martínez R. (Taxonomy Lab. CIAMEC, INIA, SARH, MEXICO)

The Aphididae family is poorly known in Mexico, but the economic importance of the damage produced by these insects to agriculture either directly or by virus transmission has raised the - need to study this group in several ways. The first step taxonomically, and this paper is part - of another more complete one trying to include the whole family in Mexico.

Taking in account the great morphological variation in this group, about 300 samples were analized from places and crops where aphids have been found causing economic damage. The first - aim is produce keys for the identification of such species in Mexico.

In this paper notes are given about biology, biometry, geographical distribution, host plants, dates of ocurrence and economic importance of 25 aphid species in Mexico.

1R-9,28

THE THIRD SPECIES OF SINENTOMON (SINENTOMIDAE : PROTURA) FROM KOREA.

Paik, W-H. (Dept. Agr. Biol., Coll. Agr., Seoul Nat. Univ., Suweon, Korea 170)

Following the establishment of Sinentomen Yin, 1965, based on S. erythranum Yin, the second species S. yoroi IMAPATE, 1977 was reported from Japan. The third species of the genus S. chui M.S. was collected by Mr. Chu at Mt. Hw⁀ahag-san, Gyeongsang-namdo, Korea. Three species of Sinestomon may be separated by the following table.

Cheatotaxy of 3 species of Sinentomon (Maturus Junior)

		Chui MS			erythranum			yoroi	
		Dorsal +	Pleural	Ventral	Dorsal +	Pleural	Ventral	Dorsal	Ventral
Thorax	I	4		4-2-2	4		12	4	6-2-4
	II - III	8-11		4-2-2-2	8-11		12	8(10)/11	6-2-4
Abdomen	I	4-4-5	2	4-3-2	4-4-7	2	4-3-2	4-15	4-5
	II	8-8-7	4	4-3-2	8-8-7	4	4-3-2	12-19	4-5
	III	8-8-7	4	4-3-2	8-8-7	4	4-3-2	12-19	4-5
	IV-VII	8-8-7	4	4-3-4	8-8-7	4	4-3-4	12-19	4-7
	VIII	8-6-5		4-4-5	8-6-5		2-4-5	10-15	2-7
	IX	8-5		4-5	6-4		4-5	6/15(14)	5
	X	6-3		2-3	6-0		4-2	8	4
	XI	4-4-1		4-4-4-2	4-4-1		4-4-2	0	2
	XII							9	8

1R-10,30

A revision of the Serphidae (Hymenoptera)

Townes, Henry (Amer. Ent. Inst., 5950 Warren Rd., Ann Arbor, Mich., USA),

There are 310 known species of Serphidae and 25 genera. The probable world fauna is approximately 1,300 species. The genus Exallonyx contains more than half of the family. One genus parasitizes Fungivoridae. The restcof the family attacks coleopterous larvae.

1R-10,31

SIGNIFICANCE OF MORPHOLOGICAL STRUCTURES IN THE CLASSIFICATION OF INDIAN ENCYRTIDAE (CHALCIDOIDEA:HYMENOPTERA).

Alam, S.M. and Shafee, S.A. (Dept. Zool., Alig. Musl. Univ., Aligarh, India)

The subdivision of the family Encyrtidae into subfamilies and tribes as adopted by various earlier authors is discussed. Three subfamilies (Arrhenophaginae, Tetracneminae and Encyrtinae) and six tribes (Arrhenophagini, Anthemini, Tetracnemini, Aenasiini, Encyrtini and Bothriothoracini) are considered practicable. Detailed comparative study of pronotum, eighth and tenth terga, paratergites, subgenital plate and female external genitalia has been done on Indian genera of Encyrtidae. Presence or absence of paratergites is taken as distinct subfamily character. Immovably fused and movably articulated conditions of third valvulae with second valvifers are regarded as stable characters for separating most of the tribes. Differing shapes of pronotum, paratergites, tenth tergum, subgenital plate, first and second valvifers are suggested as useful generic characters. These characters along with already recognized conventional characters have made the identification of genera more stable and practicable. Separate workable keys for subfamilies, tribes and genera are proposed.

1R-10,32

SUBFAMILIES OF DOLICHOPODIDAE (DIPTERA).

Ulrich,H. (Mus.A.Koenig, Bonn. W.Germany)

The systematic arrangement of Dolichopodidae in subfamilies as proposed by Robinson, 1970 for the Nearctic and Neotropical regions, is adopted with a few modifications and applied to the genera known from all over the world. There are ten groups distinguished which may be tentatively regarded as subfamilies: Sciapodinae, Neurigoninae, Medeterinae, Systeninae (including Achalcus and Xanthina from Robinson's Xanthochlorinae), Enliniinae, Diaphorinae, Rhaphiinae, Sympycninae (including Stolidosomatinae, Peloropeodinae and Xanthochlorus), Dolichopodinae, and Hydrophorinae. Robinson's concept of Rhaphiinae, which was restricted to the genus Rhaphium, is enlarged to include Plagioneurus (former Plagioneurinae), Argyra, Keirosoma, Nematoproctus, Pseudargyra, Somillus (all from Diaphorinae), Pinacocerus (from Sympycninae), and Urodolichus. In this new concept, Rhaphiinae is composed of genera differing from those which had been assembled under the same name by Becker, 1917-24 and subsequent workers using Becker's system. Some more genera are placed differently from previous literature, viz. Bathycranium, Nurteria and, tentatively, Coracocephalus, Eucoryphus and Schizorhynchus in Sympycninae, Katangaia, Anasyntormon, Colobocerus and Microtes in Dolichopodinae, Machaerium in Hydrophorinae.

1R-10,33

SYSTEMATIC STUDY ON THE GENUS STICTOCHIRONOMUS FROM JAPAN (DIPTERA, CHIRONOMIDAE)

Yamamoto, M. (Ent. Lab., Kyushu Univ.,Fukuoka, 812 Japan)

Up to the present 29 species of the genus Stictochironomus have been recorded from the world. In Japan, Tokunaga described S. akizukii, and Asakawa recorded S. histrio. Tokunaga also described Chironomus (Polypedilum) multannulatus which, however, should be transfered to the genus Stictochironomus. According to my recent investigation on the Chironomid fauna of Japan, I was able to find out 2 more species, S. pictulus and a new species. Thus I deal with 5 Japanese species in the present study.

The genus Stictochironomus is closely allied to the Australian genus Parvitergum and African genera Nilodosis and Henrardia, but is easely distinguishable from these genera by the mesothoracic structure, male genitalia and tibial combs of middle and hind tibiae. Japanese species may be divided into 2 species groups on the bases of the colouration, body size and the structure of male genitalia.

I. The pictulus group: Body entirely blcak, large; gonocoxites nearly parallel; dorsal appendage rather long. Three species, pictulus, histrio and akizukii.

II. The multannulatus group: Body yellowish brown, rather small; gonocoxites distinctly diverging posteriorly; dorsal appendage comparatively short. Two species, multannulatus and an undescribed species.

1R-11,34

THE CICADA IN CHINESE FOLKLORE.

Riegel, G. (Dept. Zool., Eastern Ill. Univ., Charleston, Ill. 61920 USA)

In early China cicadas were regarded as symbols of rebirth or immortality. (This was similar to the symbolic use of the sacred scarab in ancient Egypt.) Stylized cicadas are found on ritual bronze vessels and carved bone spatulas of the Shang Dynasty (ca. 1550-1030 B.C.).

Cicadas carved from jade are often found in graves of the Han period (202 B.C.-220 A.D.) or earlier. Apparently these jade cicadas were placed on the tongue of the dead.

In more recent times jade cicadas were used as girdle pendants or toggles (chui-tzǔ) in a manner similar to Japanese netsuke. These pendants are still being carved today.

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1R-11,35 REVISION OF THE GENUS *ACROLEUCUS* STAL (HEMIPTERA-HETEROPTERA/LYGAEIDAE/ LYGAEINAE)

Harry Brailovsky. Departamento de Zoologia. Instituto de Biologia UNAM. Apdo Postal #
70153 Mexico 20 D.F.

The genus *Acroleucus* Stal is revised; *A. sulcatus* Osborn 1904 and *A. sceleratus* Distant 1893 are considered synonyms and are included within *A. signaticollis* Stal 1874 and *A. signoretii* Stal 1874 there being the valid species. *A. flavoseptus* is tentatively maintained within this genus as incertae-sedis. *A. vicinalis* Distant is removed from this genus and a new generic status is sugested for it. Zoogeography of the group is discussed and the polymorphism of some species are given.

1R-11,36 DIFFERENTIAL CHARACTERS SEPARATING ALL DEVELOPMENTAL FORMS OF THE WAX SCALE *CEROPLASTES FLORIDENSIS* COMSTOCK (COCCOIDEA, HOMOPTERA).

Ezzat, Y. M. and Fayez, S. S. (Faculty of Science, Al Azhar Univ., Madenat Nasr, Cairo, Egypt)

Critical examination of the four nymphal instars and the adult female of *Ceroplastes floridensis* Comstock proved that antennae, tarsal and claw digitules, stigmatic structures, disc pores, tubular ducts, setae, and peri-anal-plate scelerotization are greatly significat in differentiating among these forms. Meanwhile, the results throw some light upon the developmental pattern in this group of wax scales. They may be also used to separate among corresponding instars of different species in the same group. The discussion is supported by four plates.

1R-11,37 SIX SPECICES OF GENUS OSTRINIA (*LEPIDOPTERA:PYRALIDAE*) IN JAPAN AND COMPARISON OF ESTERASE PATTERNS BETWEEN TWO SPECIES,

S. Takeuchi (Agricutural Extention Depatment of Tottori prefecture, Japan)

I carried out those researches for find sientific name, hast plants and distribution of the corn bore and allied species (*Genus Ostrrinia*) in japan, and further the comparison of esterase patterns (by means of agarose gel electrophoresis) between two species of *O. furnacalis Guenée* and *O. scapulalis subpacifica M.andM.* results are as follows;

1) Species collected from each lacations in japan: *O. furnacalis Guenée*, *O. scapulalis subpacifica M. and M.*, *O. zaguliaevi honshuensis M. and M.*, *O. zealis centralis M. and M.*, *O. palustralis memnialis Walker*, *O. latipennis Warren*, .

2) Each species had injuried singular plant or many plants and seems to have some tendency on host preference.

3) Esterase patterns between two species of *O. furnacalis* and *O. scapulalis* were difference small.

1R-12,38

TAXONOMY AND DISTRIBUTION OF STEM-BORERS OF THE GENUS SCIRPOPHAGA IN THE WORLD (LEPIDOPTERA: PYRALIDAE). Lewvanich, A. (Ent. & Zool. Div., Dept. of Agric., Bangkhen, Bangkok 9, Thailand.

The stem-borers of the genus Scirpophaga have been known as species of economic importance. Because of external similarity among the species in this group, the identities of the various species have been very confused. The main characters used for separating the species are the genitalia, especially in the males. Thirty-seven species belonging to seven species-groups are recognized. The distribution pattern of each group is given. Study of the world species of Scirpophaga revealed that the specimens in the various collections were badly mixed and showed that because of numerous misidentifications the literature could often not be relied upon. In this work many of the taxonomic problems have been clarified. It is hoped that this will be useful not only to the taxonomists but also to any entomologists dealing with the control of these stem-borers.

1R-12,39

CERAMBYCID FAUNA OF THE RYUKYUS (COLEOPTERA).
Makihara,H.(Ent.Lab.,Kyushu Univ.,Fukuoka,812 Japan)

The Ryukyus comprise about 60 islands lying between Kyushu and Taiwan in an arc, and the insect fauna is very rich due to her geologic, climatic and biotic complexities.
Cerambycidae of the Ryukyus have been recorded about 110 genera and 230 species at present. Their faunal characters are : 1. most species are the oriental element, 2. endemism in the species level is high (about 45 %), 3. geographical variations are pronounced in many species or species groups, 4. faunal gap is demonstrated between Okinawa and Miyako Islands compaired by the Mountford's method of Nomura-Simpson's coefficients.

1P,1

Fossil bee flies (Diptera, Bombyliidae) of Cretaceous fauna.
Zaitzev, V.F., Zoolog. Inst. Acad. Sci., Leningrad, USSR.

First specimens of fossil Cretaceous Bombyliidae found in north Siberia have been studied. They were referred to two new species of different genera, closely related to the recent ones. One of the species is included into the Oligocene genus Proplatypygus Hennig, another one is identified as type species of a new fossil genus. These data supplemented by analysis of the known information on other fossil Bombyliidae allowed for a new concept about the time when primary representatives of the family originated and its main groups were formed.

1P,2

DETAILED MORPHOLOGY OF APPENDAGES (HEAD, THORAX, ABDOMEN) IN PALEOZOIC INSECTS.

Kukalova-Peck, J. (Department of Geology, Carleton University, Ottawa,Ont.KIS 5B6,Canada

Morphology of some Paleozoic insects gives clues for identification of head and abdominal appendages and legs of modern insects. In some fossils the maxillary and labial palps are terminated by posttarsal claws, and thus are identified as homologues of legs; the abdomen carries a series of small abdominal legs and one or two pairs of male gonopods, also terminated by claws. In the female genitalia, the clawed appendage was found articulated with the ovipositor and indicative of its parts. Both sexes had annulated gonapophyses like Recent machilids. Palps and gonopods had a freely articulated patela as in spiders. The number of visible segments in the legs of some Paleozoic insects is higher than anticipated, probably 11, or maybe even 12.

1P,3

Intercontinal relationships as evidenced by Lepidoptera with remarks on evolution of these insects.

Skalski,A.W./Museum of Częstochowa,Poland/

New records of fossil Lepidoptera of Cretaceous and Tertiary in age provide important insights into the origin, evolution and past dispersal of these insects. Oldest remains of the Lepidoptera come from Cretaceous period. They are represented by Homoneura, Nepticulidae and Tineoidaea. Many of fossil forms of that agree with several recent groups resticted to the Southern Hemisphere. Fossil records and present distribution of the Lepidoptera may indicate that its main branches evolved from a common stock orignated at a north land plate before it rifting began into several land masses.

1P,4

THE ITALIAN SPECIES OF THE GENUS GRYLLOTALPA.

Baccetti, B. and Capra, F. (Institute of Zoology, University of Siena, Italy)

In Italy three groups of Gryllotalpa species exist, that are completely different from each other and distinguishable on the basis of chromosomal equipment and of some morphological characters as the shape of the titillator and the wings nerves. To the first group only Gryllotalpa gryllotalpa belongs, with 12 chromosomes and always long wings, european taxon, penetrating in Italy from Alpes, along Apennines to northern Campania, without reaching islands. At our opinion it is an element recently penetrated in Italy, probably during Quaternary. This second group includes numerous populations distinguishable only on the basis of the chromosomal equipment. Each of them can be present or in the long winged or short winged form. This group includes, in addition to G. 17- chromosomica described by Ortiz for Spain and southern Franch, and limited, for Italy, to Tuscany and Umbria, a 20- chromosomes form (G. viginti) in Ligury, a 15- chromosomes form (G. quindecim) in southern Italy and Sicily, and two mixed species, one with 16 (G. sedecim), one with 18 (G. octodecim) chromosomes in the Po river region, in Sardinia and, probably, in Corsica. The third group includes only G. cossyrensis, of Pantelleria, probably present also in Northern Africa and Palestine. This species has certainly a S. mediterranean affinity, and is characterized by 24 chromosomes in the female and by several morphological features.

1P,5 EVOLUTIONARY STATUS OF *DROSOPHILA ALBOMICANS*.

Ranganath, H.A. Krishnamurthy N.B., & Rajasekarasetty, M.R. Dept.
Zoology, Manasagangotri, Mysore 57006, India.

D. albomicans Duda(2n=6) is a member of the *Immigrans* group of *Drosophila*. Wilson *et al* (1969) and Kitagawa (1976) consider it as a full fledged species. But Nirmala and Krishnamurthy (1972) & Ranganath *et al*. (1974) have adduced evidences to the effect that *D. albomicans* is a chromosomal race of *D. nasuta* Lamb (2n=8). Present authors have conducted following hybridization experiments to decipher the biological status of *D. albomicans*: (a) Karyotypic mosaicism in the hybrid populations (b) Analysis of chromosome constitution of the gametes produced by F1 individuals (c) Fertility tests (d) Coadaptation in the genetic systems of the parents. The results of these indicate that eventhough there is partial sterility in the hybrids, *D. albomicans* and *D. nasuta* have mutually open genetic systems. Hence we suggest that *D. albomicans* should be treated as a chromosomal race of *D. nasuta*. Genetic basis of speciation in Drosophila will be discussed.

1P,6 HISTORIC BIOGEOGRAPHY OF SOUTHERN AFRICA.

Endrödy-Younga, S., Transvaal Museum,
P.O. Box 413, PRETORIA, 0001, Republic of South Africa.

An attempt to correlate generic distributions of Coleoptera with present ecological zonations provided positive results only in phytophagous groups. Ultimately the generic distributions of wingless, terrestrial and non phytophagous groups extend through a range of phytogeographic zones in a number of different patterns. It was concluded that the prevailing (i.e. changing) climatic conditions, best reflected by the phytozonation of any given era, only modulate the pattern of generic distributions, directed primarily by the evolution of taxa concerned. Thus insect groups of various phylogenetic ages, grade of specialization and rate of vagility provide information on ecological conditions at the time of their origin in various geological ages. A study on the historic biogeography of Southern Africa presented is based on these principles.

1P,7 PROBABLE INTERSPECIFIC ISOLATION MECHANISMS IN THE ORIENTAL SPECIES OF THE XYLOTA PENDLEBURYI GROUP (DIPTERA, SYRPHIDAE).

Hippa, H. (Dept. Biol., Univ. Turku, Turku, Finland)

It has not yet been shown whether the differences in the structure of the male genitalia in Syrphidae merely reflect general genetic differences or have the function of an isolation mechanism. The genus *Xylota* comprises a number of groups of externally greatly similar species, but with pronounced differences in the structure of the genitalia. In the species of the *X. pendleburyi* group the genitalia are unusually simple and similar, due to synapomorphous reduction, and seem to allow only limited structural diversity. In this group a number of unusual secondary male characters have evolved on the legs. The interspecific differences in these and in genital morphology are in negative correlation. In sympatric or closely adjacent species the differences seem to be the most pronounced. This suggests that the two sets of characters relate to the same phenomenon, i.e. apparently the maintenance of isolation between populations.

1P,8

THE WAYS OF KARYOTYPE EVOLUTION IN INSECTS WITH HOLOKINETIC CHROMOSOMES, Kuznetsova, V. (Zool. Inst., USSR Acad. Sci., Leningrad 199164, USSR).

In animal kingdom holokinetic chromosomes are found only in insects and in few other arthropods. Such chromosomes are characteristic of three unrelated groups of insects, namely Dermaptera, all Paraneoptera (Psocoptera,Anoplura,Mallophaga,Thysanoptera,Homoptera,Heteroptera) and Trichoptera + Lepidoptera.Three ways of karyotype evolution in these insects are proved using chromosome morphometry,DNA cytophotometry,experimental X-raying of chromosomes and interspecific cross-breeding.The first way is fragmentation or fusion of chromosomes. The fragments have their own kinetic system and keep their role in karyotype.The capability of chromosomes with diffuse centromere to fragmentate is highly adaptive unlike that of monokinetic ones with their single centromere.Two other ways of evolution are polyploidy and polyteny of chromosomes with subsequent disjunction of chromatids.All three ways may lead to speciation.The above ways of karyotype evolution,especially fragmentation and fusion of chromosomes give a good explanation of the high variability of chromosome numbers in these insects.

1P,9

Peculiarities of Morpho-Biological Evolution and Classification of parasitic Hymenoptera of the Family Aphelinidae.

Yasnosh V.A. Research Institute of Plant Protection. Tbilisi.

Aphelinidae constitute one of the most important groups of entomophagous insects that are successfully used for biological control of coccids, aleyrodids and aphids. The examination of general regularities of morpho-biological evolution, that determines any tipes of host-parasite relations, and treatment of the natural system of the classification of the family would be employed to more rational use of aphelinigs for biological control.

Morphological evolution of the family directed to dicrease the size of the body accompanied with simplification of morphological structures, more light colour, tendency of species formation without visible distinctions in morphology of adults and parallel development of the same morphological characters in the genetical distinct groups. Main direction of biological evolution of aphelinids is the narrow trophic specialisation (specific to one or a few number of hosts). Aphelinidae is a rapidly evolving, highly specialised family of Chalcidoidea. These principles lay down in the new classification of the family.

1P,10

Evolution and phylogenetic relations in subgenuses Aphodius genus.

Nikritin L.M., USSR, Moscow 139, Orlikow 1/11, Departm. Agriculture.

External morphological features and the structure of genitales in species of different Aphodius subgenera were analysed and an attempt was made to find out phylogenetic relations among them Aphodius originales from the common ancestor of the whole Aphodiini tribe and the genus has a number of typical features: the structure of pronotax, meta- and post tarsus, and the fore wings. Larvae also have common featuresin thier structure; ovale-shaped lateral protubernces in the hind part of the anal segment, the transyerse anal slit, the structure of antennae, etc. Evolutionory development of Aphodius had tut ways: 1) by morphological specialization for insect' well-being in sand desert and similar biocenosies, ther specific features are: the granular clypeus, the structure of meta and post tarsus and the claus on femur, the light colour of coverings; 2) by ecologo-morphological plasticity (in most species of Aphodius) insect of the second group are mainly true coprophags and they are capable of lining in any station. The morphological features of different representatives of this main branch in Aphodius have much in common. In species diagnosis the morphological structure of genitales and edeagus structure in particular is features mentioned above are of importance mentioned anly together with a number of other morphological geatures which were formed in the process of Aphodius evolution.

1P,11 SOME NEW CHALCID PARASITES (HYMENOPTERA:ENCYRTIDAE) RECORDED FROM INDIA

Agarwal, M.M., Agarwal, S. and Khan, Majid Ali. Dept. Zool. A. M. U. Aligarh. India

Sabirella gen.n. runs close to Adelencyrtus for having quadridentate mandibles. It shows differences in the frons, antennae, abdomen and ovipositor. It also has no relevance to other genera with quadridentate mandibles-Trechnites, Qadrencyrtus, Ixodiphagus and Anabrolepis. Sabirella indica sp.n. has been designated as its genopype. Genus Bothriophryne Compere is reported for the first time form India and B. Tachakawai sp.n. and B. latiscapus sp.n. described as new species. Subgenital plate and compoments of female ovipositor are emphasised for generic diagnosis.

1P,12 A NEW FAMILY OF ORTHOPTERA

Rentz, D.C.F. (CSIRO, Division of Entomology, P.O. Box 1700, CANBERRA, A.C.T. 2601.

A new family of ensiferan Orthoptera, called Cooloolidae, is based on a single genus and species from southeast Queensland, Australia. Its relationship with other families indicates that it should be included in the Gryllacridoidea near the Stenopelmatidae. The species is unique in many characters including peculiar antenna reduced in size and article number; mandibles reduced in size relative to maxillae; maxillae with lacinia lanceolate, seemingly for piercing; highly modified legs with fore and hind legs of nearly equal lengths and male tarsi as long or longer than adjacent tibia; males brachypterous, females apterous; both sexes fossorial, females obligatorily subterranean.

1P,13 PHYLOGENY OF THE FAMILY CHRYSOMELIDAE (COLEOPTERA) BASED ON THE COMPARATIVE MORPHOLOGY OF THE INTERNAL REPRODUCTIVE SYSTEM.

Suzuki, K. (Dept. Biol., Toyama Univ., Gofuku, Toyama, 930 Japan)

The general structures and homologies of organs of both male and female internal reproductive systems in 18 subfamilies of the family Chrysomelidae were discussed based on the results obtained from comparative morphology of them. About 200 species (mainly Japanese) belonging to about 100 genera were studied. The phylogenetic relationships among subfamilies were discussed chiefly based on the present results as compared with a number of opinions which have hitherto been proposed by many workers from various standpoints. A taxonomic rearrangement of 19 generally accepted subfamilies into 9 subfamilies and 19 tribes was also proposed. Seven major phylogenetic lines for these 9 subfamilies were presented as follows: (1) Lepturinae (Cerambycidae) —— Orsodacninae; (2) Lamiinae? (Cerambycidae) —— Megalopodinae (Zeugophorini + Megalopodini); (3) —— Sagrinae (Sagrini + Donaciini + Criocerini); (4) —— Synetinae; (5) —— Chrysomelinae (Aulacoscelini + Chrysomelini); (6) —— Galerucinae (Galerucini + Alticini); (7) —— Clytrinae (Clytrini + Cryptocephalini + Chlamisini + Lamprosomatini) + Cassidinae (Hispini + Cassidini) + Eumolpinae (Megascelini + Eumolpini). The possibility of polyphyletic origin of this family was suggested.

1P,14

THE PHYLOGENY OF THE INCURVARIOIDEA OF THE WORLD (LEPIDOPTERA).

Nielsen, E. S. (Dept. Ent., Zool. Mus. Univ. Copenhagen, 2100 Copenhagen 0, Denmark)

The monophyly of the superfamily Incurvarioidea is demonstrated by a suite of autapomorphies, and the possible systematic position of the superfamily is outlined. The assumed incurvarioid ground plan is presented, and based on a cladistic analysis of all constituent genera, the Incurvarioidea are shown to be comprised of four major groups, all of family status: Heliozelidae, Adelidae, Incurvariidae and Prodoxidae, the last-mentioned comprising four subfamilies: Crinopteryginae, Cecidosinae, Lamproniinae and Prodoxinae. The monophyly of these family groups and their phylogenetic interrelationships are discussed. For each of the families a cladogram presenting the interrelationships between the comprised genera and genus-groups is provided, and a tabular enumeration of the characters upon which the cladograms are based is given. The distribution of all higher categories is mapped.

1P,15

ON THE SYSTEMATIC SIGNIFICANCE OF THE PATTERN OF POSTEMBRYONIC DEVELOPMENT OF SCOLI IN CERTAIN GENERA OF THE SUBFAMILY NYMPHALINAE (LEPIDOPTERA: NYMPHALIDAE).

Nakanishi, A. (Biol. Lab., Coll. Gen. Educ. Kyushu Univ.-01, Fukuoka 810 Japan)

The number, distribution and shape of scoli were investigated in the 2nd to 5th istars of 25 species belonging to 13 genera of the subfamily Nymphalinae from Japan and the Philippines. Based on the result a basic plan was inferred for the distribution and shape of scoli through the postembryonic development as follows: only D scoli were recognizable in the 2nd instar on T2-A8 as small protuberances; during the successive molts these protuberances developed into scoli, and SD and L scoli were appearing; consequently the 5th instar had D, SD and L scoli on T2-A8, A2-8 10 and A1-8 respectively. Deviation from the basic plan is summarized in the following way: (1) emergence of new scoli such as HD, MD, SVU, SVL and V, (2) addition of D, SD and L scoli on several body segments, (3)acceleration of development of scoli. MD scoli emerged in all the investigated genera except for *Inachis*, and developmental pattern of the scoli was represented by four types as follows: (1) 2nd instar with a mediodorsal seta each on A5-8, which is replaced by MD scolus on A(6)-8 in the late instars (*Nymphalis)*; (2) 2nd instar with one weak protuberance each on A1-8, which developed into MD scolus in the late instars (*Aglais, Vanessa*); (3) 2nd instar already with one distinct MD scolus each on A1-8 (*Kaniska, Polygonia, Araschnia, Symbrenthia*); (4) similar to the preceding type but one additional scolus appearing on A8 (*Precis, Hypolimnas, Kallima, Doleschallia, Rhinopalpa*). Addition of SD scolus was found on A9 (*Inachis*), A1 (*Araschnia, Symbrenthia*), A1 & 9 (*Nymphalis, Aglais*) in the late instars, on A1 & 9 (*Vanessa, Kaniska, Polygonia, Precis, Hypolimnas, Kallima, Doleschallia*), T1 and A1 & 9 (*Rhinopalpa*) already in the 2nd instar. As shown in the above mentioned example, the pattern of postembryonic development of scoli is thought to be significant for the systematics of nymphaline butterflies.

1P,16

THE PUPAL WING TRACHEATION AS A SYSTEMATIC CHARACTER IN THE FAMILY PIERIDAE.

Yata, O. (Biol. Lab. Coll. Genera. Educ., Kyushu Univ., Fukuoka, 810 Japan)

The pupal wing tracheation of 26 pierid species belonging to 10 Japanese and 4 Philippine genera was described and discussed. Although the pupal tracheation shows some intra- and inter-specific variations, the typical tracheal patterns were constant within each genus. The "basic plan" of pupal wing tracheation was inferred as follows: Forewing with 15 primary tracheae (Sc, R1, R2, R3, R4, R5, M1, M2, M3, CuA1, CuA2, CuP, 1A, 2A, 3A); hindwing with 11 primary tracheae (Sc+R1, Rs, M1, M2, M3, CuA1, CuA2, CuP, 1A, 2A, 3A). The deviations from the basic plan are as follows: The loss of some primary tracheae except for Sc (in all the species); the development of secondary tracheae (R trachea in *Eurema*, *Colias*, *Catopsilia*, *Gandaca*, *Anthocharis*, *Aporia* and *Pieris* and Cu trachea in *Aporia*, *Appias* and *Pieris*); the extreme proximity or adherence of adjacent tracheae (*Leptidea* and *Hebomoia*); the modification to "pseudo-pectinate type" branching of R trachea (*Appias*, *Pieris* and *Pontia*); the apical or basal shift of tracheal branching points (*Leptidea*, *Anthocharis* and *Aporia*). In all cases the loss of trachea M is compensated by the development of secondary trachea R. The grouping based on the pupal tracheal patterns (*Colias* - *Catopsilia*, *Appias* - *Pieris* - *Pontia*)coincides with those based on the external structures of previous authors. These results strongly suggest that the pupal wing tracheation can be used as a valuable systematic character. The pupal tracheation is useful for the interpretation of vein homologies in the family Pieridae, but in some cases comparative morphological criteria should be applied to at least radial and median veins. The "discal cell folds" in the imaginal wing, which are closely related to the pupal wing tracheae, R and M, also can be used as a systematic character.

1P,17

THE ANT FAUNA OF THE TSUSHIMA ISLAND, WITH A COMPARISON WITH THE ANT FAUNAS OF THE ADJACENT AREAS.

Onoyama, K. (Nishi-2-sen 15, Inada-cho, Obihiro 080, Japan)

A total of 44 species of ants were recorded from the islands of Tsushima (42 species) and Iki (16 species). Almost all species of the Tsushima Island (T) are also distributed in northern Kyushu (N), and probably in the Korean Peninsula (K). At present, there is no eminent difference among the faunas of T, N, and K. However, the fauna of T more closely resembles that of N than that of K, as in the other insects, in that several species are found only in K. These results may be explained by the geographic distribution of the vegetation and/or Kira's warmth index values. One species (Paratrechina sp.) and another one (Proceratium sp.) have been hitherto known only from the Tsushima Island and the Iki Island, respectively.

1P,18

Numerical pattern analysis of members of the Yponomeuta padellus-complex (Lepidoptera, Yponomeutidae).

Povel, G.D.E. (Dept. Syst.&Evol.biol.,Univ.Leiden,The Netherlands)

With the aid of clustering techniques, it was possible to prove the existence of distinct taxa within the Yponomeuta padellus-complex. These taxonomic units show an absolute hostplant preference. Close examination of the results of the cluster analysis revealed a subset of discriminative characters for these taxa.

1W-1,1

I) SOME TRENDS IN EVOLUTIONARY INSECT TAXOMONY

Ghilarov, M.S.(Inst.Evol.Morph.Ecol.Acad.Sci.,Moscow 117071,USSR)

Modern taxonomy has both the analytical tasks (identification of insect) and synthesizing ones (elaboration of a classification based on natural hierarchy of taxa) reflecting the results of insect phylogeny. Numerous systems of insects proposed in the current century pretend to reflect their phylogenetic relationships though often the concepts of insect evolution accepted by varous authors are mutually excluding. As examples may serve systems proposed by Handlirsch or by Martynov and based on other principles rather coinciding systems proposed by Ghilarov, Mackerras, Grandi etc. The modern system especially of higher taxa must be based on data not only of morphology (including internal anatomy and karyology) but also of ecology, ethology, physiology and biochemistry.

Numerical taxonomy can be of value for analytical purposes of systematics and for checking proposed systems but not to construct a natural classification.

1W-1,2

INTEGRATED INSECT TAXONOMIC TECHNIQUES ON THE DERMAPTERA WITH SPECIAL REFERENCES TO MORPHOMETRIC AND PATTERN ANALYSES.Sakai,S.(Inst.Biol.& Chem.,Daito Bunka Univ.,Takasaka,Saitama,355Japan)

Insect taxonomy may be located as the integrated or hybrid science concerned to contemporary systematic phylosophies,numerical taxonomy,chemotaxonomy,biomechanical or physico-electronic analysis,cytotaxonomy and so on.The topological and stereologic morphometric analyses of the forms of the forceps and the genitalia of the different Dermapterous species were carried out.The results observed were analyzed by multivariate statistical analyses including PCA.In the species level, the stereologic analyses for the forceps of the male adults of *Anisolabis maritima* (Bonelli) and *Labidura riparia japonica* (de Haan) collected from 24 to 26 different localities in Japan did not exhibited an inclination for geographical clinal variation. Stereologic studies deal with the sequential length of forceps or genital paramere,stereologic graph of the rose of the number of intersections in radial axis and omega degree of orientation of the form of the forceps or the paramere in the genitalia.In the genitalia level,the scanning electron microscopic photographsof the paramere of the male genitalia of 3 species were observed to be covered by the so many interesting spines.The species specificity of the chitinous spines of the paramere of the different species was presented by the scanning electron microscope.Morphometric studies of the forms of the parameres of 89 species in *Forficulidae* trend towards which are relatively uniform for analytical variables of the sequential paramere length by PCA but the score distribution of each species indicated to be relatively scattered in4 axes in 2 dimension by PCA.The stereologic and clustering analyses of the paramere of the genitalia in *Forficulidae* according to 13 divisible different types are not in agreement with the corresponding genus levels. The species specificity of the chitinous spines of the paramere was also presented by photo pattern analysis. The coloration of the elytra of *Labidura riparia japonica* (de Haan) were recognized by photo pattern analyzer and color difference meter.

1W-1,3

ROLE OF MORPHOCLINAL ANALYSIS IN SYSTEMATICS AS A BRANCH OF NATURAL SCIENCE. Takagi, S. (Ent. Inst., Hokkaido Univ., Sapporo, 060 Japan)

Analysis of morphoclines itself, though in accord with some basic evolutionary generalizations, is a purely logical process. Evolutionary assumptions based on it reamin within the frame of logical probability and offer no scientific explanation. Here needed are: to apply a theory to the observed morphoclinal phenomena, and to test it by further observation on phenomena expected from it. Real and fundamental difficulty in proceeding with systematics as a branch of natural science is, therefore, found in theoretical poverty of biology on the level of systematic phenomena.

1W-1,4

A similarity measure for comparing diffent classification by using information theory.

SHIYOMI, M. and S. SAKAI(Natl. Grssl. Res. Inst. and Daito Bunka Univ.)

Many techniques of numerical classification have been developed. If different techniques are used for analysis, different classifications will be obtained; if different variates or different samples are used for classification, different results may be derived. These results are also different from the classification by systematics. Here, a similarity measure for comparing classifications is required. A measure using Brillouin's(1962) information theory is proposed for this purpose in this report. An example in numerical classification of Labiduridae will be shown.

1W-1,5 SAC COMPUTER SYSTEM FOR CLASSIFICATION USING THE GENUS ANDRENA (HYM., ANDRENIDAE) OF JAPAN.

Tadauchi, O. (Entomol. Lab., Fac. Agr., Kyushu Univ., Fukuoka 812, Japan)

SAC computer system for Andrena classification including the following 10 programs is presented: 1) taxa grouping by cluster analysis; 2)-4) character analysis by PCA and factor analyses; 5) description printing; 6) specimen identification; 7) key construction; 8) taxon-taxon comparisons; 9) inversion of taxa-by-character lists; 10) distribution mapping. The system is widely available for classification of organisms. Data matrix using in the present study is derived from 130 external morphological characters chosen from 85 female OTU's (operational taxonomic units) of the genus Andrena (Hym., Andrenidae) of Japan. This system is primarily edited for timesharing computer (TSS). Examples of the use of these programs are discussed, using printout lists from program runs.

1W-1,6 INTRASPECIFIC AND INTERSPECIFIC ALLOMORPHOSIS OF THE HIND WINGS IN THE SUBFAMILY LEPTURINAE (COLEOPTERA, CERAMBYCIDAE).

Suzuki, K. (Dept. Biol., Toyama Univ., Gofuku, Toyama, 930 Japan)

1) Intraspecific allomorphic transformation patterns of the hind wings in 27 lepturine species were analyzed. First, three species of them and 4 species of other subfamilies were statistically analyzed; i.e., 6 points were defined on the hind wing and lengths of 11 lines and the areas of 5 triangles constructed by combination of the 6 points were measured or calculated and statistically analyzed. Second, the intraspecific allomorphic transformation patterns of the other 24 lepturine species were assumed by a modification of D'Arcy W. Thompson's "Cartesian transformation method" and major 2 types were recognized in them. The so-called "Burla's rule" established by Okada ('59, '60) for drosophilid flies and some other winged insect groups was widely recognized in the subfamily Lepturinae, though the rule was considered to cover only a phase of allomorphic transformation in insect wings.; 2) Interspecific allomorphic transformation patterns of the hind wings in 47 lepturine species were also analyzed. Relationships between the interspecific allomorphic transformation patterns and the taxonomic groupings were discussed. Through comparison of the values of 7 interspecific allomorphic constants (α), the interspecific allomorphic transformation pattern of the hind wings in the 2 tribes Stenocorini and Lepturini were revealed. A model explanatory of the evolutionary processes in the hind wings in the subfamily Lepturinae was presented.

1W-1,7 HARMONIC ANALYSIS OF THE SHAPES OF THE ELYTRA IN THE HENOSEPILACHNA VIGINTIOCTOMACULATA COMPLEX (COLEOPTERA: COCCINELLIDAE).

Miyai,S.(Div.Ent.,Kochi Prefec.Inst.Agr. & Forest Sci.,Kochi, 781-21 Japan)

Harmonic analyses in the form of Fourier equations were applied to describe the shapes of the elytra of the Henosepilachna vigintioctomaculata complex. The shapes were represented by two shape curves to which the Fourier equations were fitted by the least squares technique. The curves were sufficiently approximated by the equations with 5 or 6 cosine terms, so they could be interpreted numerically by the corresponding Fourier coefficients.

Using these coefficients obtained for each individual, the patterns of geographic variations of elytra shape in the H. vigintioctomaculata complex were examined by some multivariate statistical procedures.

1W-1,8

8) CYTOTAXONOMIC STUDIES ON THE CHROMOSOMES OF THE DERMAPTERA, WITH SPECIAL REFERENCE TO EVOLUTIONAL CONCIDERATION. Hoshiba,H. and Sakai,S.(Daito Bunka Univ.Daiichi High School, Itabashi, Tokyo,175 Japan and Daito Bunka Univ., Takasaka, Saitama,355 Japan)

The chromosome number of Dermaptera, up to 23 species have been counted from 10 to 38.
The chromosome number of *Labidura riparia japonica*(de Hann) was found to be 14(12+XX in the female and 12+XY in the male). This striped earwig showes its own characteristics that the autosomal bivalants condence heterogeniously in the male meiosis I, i.e., four bivalants including the sex bivalant condence first and other three bivalants condence later.
The chromosome number of a species of the mountain living earwig in Japanese endemic Dermaptera, *Forficula mikado* Burr was found to be 24(22+XX in the female and 22+XY in the male).
In the genus *Labidura*, a fusion of the chromosomes of No. 4 and 5 of the 2n=14 chromosomes group(*Labidura riparia*(Pallas)(India), *Labidura riparia japonica*(de Hann)) may have a role to evolve into the 2n=12 chromosomes group(*Labidura riparia*(Pallas)(Spain), *Labidura bidens*(Oliver), *Labidura bengalensis* Dohrn), and a fusion of No. 4,5 and 6 may have a role to evolve into the 2n=10 chromosomes group(*Labidura truncata* Kirby), and if a breakage occured instead of a fusion, it would evolve toward the opposite direction.
The chromosome in these genus have mentioned to be holocentric, however, the lacalized single centromere in each chromosome of the ovarian follicle cell of *Forficula mikado* Burr was clearly observed.

1W-1,9

SOME APPROACHES FOR QUANTITATIVE ESTIMATION ON VARIATION OF INSECTS IN EXTRA- OR INTRA-SPECIFIC LEVELS. Koike,H.,(National Inst.Agr.Sci.,Tokyo 114 Japan)

Quantitative evaluation of biological character is very important in integrated or molecular taxonomy. In this report,application of photometric method,biochemical analysis and electron microscopy on some insects were presented.

Microphotopattern- and spectrophotopattern-analysis on wings of *Sasakia charonda* showed that wing pattern and shape showed different trend geographically.

As results of biochemical analysis,three examples were presented. 1) Differentiation in food habit in lepidopterous insect belonging to same genus was presented and significance of increase in isozyme fractions especially in sucrase and amylase was pointed. 2) Geographic variation in protein fractions and insecticide susceptibility in the rice stem borer,*Chilo suppressalis*, and the planthoppers were presented. 3) Geographic variation in pools of glycolytic intermediates in the planthoppers were presented.

Pigment granules,observed by scanning and transmission electron microscope,in scale of the rice stem borer or on integument if the leafhoppers also showed important role in discriminating variation in intr- or extra-specific levels.

1W-1,10

Some chemotaxonomic information on Dermapterous and Orthopteroid insects

Okuda,S. & SAKAI,S.(Inst.Biol.&Chem.,Daito Bunka Univ.,Takasaka,Saitama,355 Japan)

Chemotaxonomic method integrates readily into the standard body of the taxonomic method.Chemotaxonomic approaches from inorganic biochemorphology of sodium,potassium and calcium, and protein chemistry involving cholinesterase activities,amino acid constituents and nitrogenous end products promise to be of importance in the development of the understanding of relationships between higher taxa levels of Dermaptera and Orthopteroidea.The inortanic ion compositions of head,thorax,abdomen,legs and hemolymph in *Anisolabis maritima* (Bonelli),*Periplaneta americana* (L.),*Patanga japonica* Bollvar were analyzed respectively. The results on the maritima earwig were relatively higher than the previous results. The maritima earwig and the American cockroach were expected to be abundant in protein,peptides and amino acids. 11 Amino acids including alanine,appartate,cystine,glutamate,isoleucine,lysine,phenylalanine tyrosine and valine were detected in the male adult of the maritima earwig. The total nitrogen values of a Forficulid earwig,*Forficula mikado* Burr belonged to the higher earwig were distinguished from the test earwigs, *Anisolabis maritima* (Bonelli), and *Gonolabis marginalis* (Dohn) in *Carcinophoridae* and *Labidura riparia* (de Haan) in *Labiduridae* which belong to the lower earwigs. It was shown that the activities of AChE of the above two species in *Carcinophoridae* were higher than that in *Labiduridae* and *Forficulidae*. The activities of AChE of the three parts of the body in the Japanese spotted-legged earwig,*Gonolabis marginalis* (Dohrn) were head,abdomen and thorax in the descending order and the AChE activity of the head recorded 10 times value to the other parts. The atom absorption flame spectrometer analyses of Dermapterous and Orthopteroid insects were carreid out. The comparative chemotaxonomic experiments are discussed from the point of view of phylogeny.

1W-1,11

COLORIMETRIC AND ELECTROPHORETIC INFORMATIONS ON ORTHOPTEROID AND DERMAPTEROUS INSECTS.

Terata,K. and Sakai,S.(Inst.Biol.&Chem.,Daito Bunka Univ.,Takasaka,Saitama,Postcode;355,Japan)

In non-specific esterases of Orthopteroid insects, alpha-(beta-)napthyl acetate was adopted as a substrate suitable for measuring esterase activites, because of the relative large value of absorbance on cololimetric analysis. Some Orthopteroid and Dermapterous species were made electrophoresis and Orthopteroid specimens were classfied into two groups from the similarity of the zymogram pattern of esterases involving cholinesterase: group 1 includes Phaphidophorinae(*Diestrammena apicalis* and *Tachycines asynamorous*), Phaneropterinae(*Phaneroptera fallata*) and Cococephalinae(*Homorocoryphus lineosus* and *H. jezoensis*), and group 2 inclues Gryllinae(*Telleogryllus emma, T. taiwanemma, T, yezoemma, T, sp., Loxoblemmus doenitzi, L. aomoriensis, L. sp.(Moriokame), L. sp.(Haraokame), Velarifictorus aspersus, V. parvus, V. sp., Gryllodes sigillatus, Gryllus bimaculatus, Cardiodactylus novae-gueneae, Duolandrevus coulonianus, Pteronemobius fascipes, P. csikii, P. taprobanensis, P. nitidus, P. ohmachii* and *P. flavoantennalis*),Scleropterinae(*Scleroptenus coriaceus*), Trigonidiinae(*Trigonidium cicindeloides*), Eneopterinae(*Dionynus marmotatus, Calytotrypus hibinonis* and *Euscirtus cicindeloides*) and Phalangopsinae(*Homoeogryllus japonicus*), and Dermapterous ones were classfied into two groups:group 1 including ex-Protodermapterous species(*Anisolabis maritima* and *Liparia riparia japonica*) and group 2 including ex-Eudermapterous one(*Foruficula mikado*). Furthermore, a few species of the genus of Pteronemovius were intraspecifically and temporally examined based on electrophoretic results of several enzymes and souluble proteins of their leg-muscles.

1W-1,12

12) THE WAYS OF KARYOTYPE EVOLUTION IN INSECTS WITH HOLOKINETIC CHROMOSOMES.

KUZNETSOVA,V.G.(Zoological Inst.,Acad. of Sciences,Leningrad,V-164,USSR)

In animal kingdom holokinetic chromosomes are found only in insects and in few other arthropods. Such chromosomes are characteristic of three unrelated groups of insects,namely Dermaptera,all Paraneoptera(Psocoptera,Anoplura,Mallophaga,Thysanoptera,Homoptera,Heteroptera) and Trichoptera + Lepidoptera.

Three ways of karyotype evolution in these insects are proved using chromosome morphometry,DNA cytophotometry,experimental X-raying of chromosomes and interspecific cross-breeding. The first way is fragmentation or fusion of chromosomes. The gragments have their own kinetic system and keep their role in karyotype.The capability of chromosomes with diffuse centromere to fragmentate is highly adaptive unlike that of monokinetic ones with their single centromere. Two other ways of evolution are polyploidy and polyteny of chromosomes with subsequent disjunction of chromatids. All three ways may lead to speciation. The above ways of karyotype evolution,especially fragmentation and fusion of chromosomes give a good explanation of the high variability of chromosome numbers in these insects.

1W-1,13

13) SPECIES DYNAMICS IN DERMAPTERA

SRIVASTAVA,G.K.(Zoological Survey of India,14 Madan Str.,Calcutta-700072,India)

A species,in nature is represented by large number of populations consisting of variable number of individuals which may or not be identical morphologically. An account of intraspecific variations in 10 species of Dermaptera demonstrates that species is a dynamic biological unit. Moreover, such information not only helps in stabilizing the taxonomic status of various species but also in tracing their phylogenetic relationship.

1W-2,1 Community structure in water beetle societies - data from nature and expectation from model

Flechtner, G. and U. Halbach, Department of Biology, Y. M. Goethe University, Frankfurt, W. Germany

1W-2,4 DISTRIBUTION OF THE GENUS COPELATUS IN JAPAN (COLEOPTERA, DYTISCIDAE).

Satô,M. (Biol. Lab., Nagoya Women's Univ., Nagoya, 468 Japan)

The species in the genus Copelatus has confused to identify, because it is closely similar each other in their external morphology. Examination of the male aedeagi has revealed useful character for separating. Resulted from the review of the genus in Japan, I enumerated 11 species. Of these 6 species are endemic, 3 are widespread and 2 are of uncertain. Although most species seems to be the southern element.

1W-3,1 TAXONOMY OF DASINEURA AND ALLIED GENERA (OLIGOTROPHINI: CECIDOMYIIDAE). Sylvén, E. (Sect. Ent., Sw. Mus. Nat. Hist., S-104 05 Stockholm, Sweden)

Adult characters in more than 100 species distributed among Dasineura Rondani and allied genera were studied. Morphometric data related to wing and ovipositor were statistically treated by computer technology, and were found to be useful in distinguishing most of the species. Examinations of various characters indicate that several genera erected by earlier authors are to be synonymized with Dasineura. Structural adaptations in relation to the habits of the adults are discussed. Briefly, phyletic weighting of certain characters is also dealt with.

1W-3,2 THE CONTRIBUTION OF CECIDOMYIID SPERM IN THE PHYLOGENY OF THE GROUP.

Dallai, R., Baccetti, B. and Mazzini, M. (Inst. Zool., Siena Univ., Siena, Italy)

Gall-midge Cecidomyiids exhibit the most unusual and variable sperm models so far discovered in insects. The sperm structure may indicate different evolutive trends within the family.

Cecidomyiinae, the best studied group, show two main evolutionary lines. The first contains the species whose spermatozoa are motile and show an axoneme of "Sciara-like" model; the second contains the species whose spermatozoa are not motile. The general shape of the sperm here is variable; in the sperm flagella doublets are still evident but they lack dynein arms and in some spermatozoa more or fewer micro=tubules are also present.

Lestremiinae still show a "Sciara-like" model of sperm axoneme but have crystallized mitochondrial derivatives.

Porrycondylinae seem to be a divergent line having acquired a 9+3 sperm axoneme.

1W-3,3 ANATOMICAL TERMS FOR MALE AND FEMALE POSTABDOMENS IN CECIDOMYIIDAE. Gagné, R.J.

(Syst. Ent. Lab., USDA, Washington, D.C. 20560).

Various terms for the structure of the male and female postabdomens are currently used by cecidomyiologists. Hardly 2 workers use the same system, a situation that is confusing and counterproductive. Agreement on terminology depends mainly on homologizing the separate structures both within the Cecidomyiidae and between that Family and the rest of Diptera. A review is given of the evolution of homologous organs within the Cecidomyiidae. A system of terminology for the postabdomens, newly proposed by others for Diptera, is put forward as the authority and basis for agreement on terminology among cecidomyiologists.

1W-3,4 PLANT-INSECT RELATION BETWEEN WHITE BIRCHES (*BETULA* L., SECTION *ALBAE* REGEL) AND GALL MIDGES OF THE GENUS *SEMUDOBIA* KIEFFER (DIPT., CECIDOMYIIDAE). Roskam, J.C. and Van Uffelen, G.A.

(Div. Syst. & Evol.-Biology, Univ. of Leiden, The Netherlands)

The section *ALBAE* Regel of the genus *Betula* L. may be divided into two series of birches. The first series has pubescent twigs and is found on wet, peaty places (in West Europe *B. pubescens* Ehrh.); the second series has glabrous resin-glandular twigs and occurs in dry, sandy habitat (in West Europe *B. pendula* Roth). In spite of their difference in chromosome number (*B. pendula* 2n=28, *B. pubescens* 2n=56) many intermediate forms between these two species can be observed. Fruit galls of these white birches are induced by two species of the gall midge genus *Semudobia* Kieffer, viz., *S. betulae* (Winnertz) and *S. tarda* Roskam. Here no intermediate forms are found. Both species occur often in the same birch specimen and even in the same fruit catkin. By a statistical approach strong evidence has been obtained that *S. betulae* predominates in *B. pendula* and *B. pendula*-like birches and *S. tarda* is most common in *B. pubescens*-like specimens. I.e., although both species possess a similar niche, there is a difference of occurrence with regard to the place of the host plant specimen on a "hybrid index" of *B. pendula* and *B. pubescens*.

1W-3,5 EXTENDED DIAPAUSE IN HASEGAWAIA SASACOLA (DIPTERA, CECIDOMYIIDAE)

Sunose, T. (Ent. Inst., Hokkaido Univ., Sapporo, 060 Japan)

Hasegawaia sasacola producing a bud gall on Sasa spp. remains in diapause as prepupa in the dead gall for one year or more. The extended diapause is caused either by a genetic factor or by the delayed onset of growth. The life cycle of this species can not endure beyond five years, since the gall harvouring prepupae falls into decay in about four years.

The population density of this species is not controlled by its parasites, but seems to depend upon the physiological condition of Sasa spp. One-year cycle individuals in a local population decrease in relative frequency when the survival rate in the previous year is low, and increase when it is high. Any species of Sasa is known to flower synchronously in a geographical range at long supra-annual intervals, usually dying after the mast year. The extended diapause in this species may have adaptive value in keeping the population against such catastrophic happenings.

1W-5,1 ON THE ABDOMINAL SEGMENTATION IN ADULT FEMALE OF ARMOURED SCALE INSECTS OF THE ODONASPIDINI AND ANTAKASPIDINI (HOMOPTERA:COCCOIDEA:DIASPIDIDAE), Ben-Dov, Y. (Division of Entomology Agricultural Research Organization, Bet Dagan 50200 ISRAEL).

The number of and the distinction between abdominal segments in adult females of the Diaspididae is not clearly discernible in all tribes of this family, by use of external examination of the cuticle in slide-mounted specimens. In adult females of the Odonaspidini and Antakaspidini, abdominal segmentation is very distinct since the intersegmental sutures are most conspicuous. Following observations on slide-mounted female specimens of all available species of these two tribes, it appears that their abdominal segmentation exhibits a pattern previously not recorded in the Diaspididae. Each of the three anterior segments is constructed of its separate tergite and sternite. The fourth and fifth segments each possess a separate tergite and ventrally a separate paratergal area. Whereas the ventral median and submedian areas (i.e. between paratergal areas) of both segments became fused, and they appear as a joint area bordered anteriorly and posteriorly by intersegmental sutures.

1W-5,2 WAX FILAMENTS ON COCCID EGGS. Gerson, U. (Ent. Dept., Agric. Fac., Hebrew Univ., Rehovot, Israel.

Scanning electron microscopy of eggs deposited by members of six coccid families (Margarodidae, Pseudococcidae, Eriococcidae, Asterolecaniidae, Coccidae and Diaspididae) showed that all eggs were densely covered by rounded filaments. Similar structures were reported from the Kermesidae, and thus it is assumed that they occur throughout the Coccoidea. The filaments are secreted from diverse ventral orifices, including the diaspidid perispiracular pores. Filaments of Planococcus and Saissetia became disorganized and shapeless after a 5-second dip in chloroform, thereby indicating their waxy nature. Although the significance of the filaments is obscure, their persistence throughout the superfamily Coccoidea, whose members have evolved various wax glands and orifices, indicates that there has been strong selection pressure to preserve them.

1W-5,3 SECOND-STAGE MALES AS A TOOL IN SCALE INSECT PHYLETICS.

Howell, J. (Dept. of Ent., Univ. of Ga., Experiment, Georgia 30212 USA)

Historically, phylogenetics within the Coccoidea have been based on characteristics of the adult females. Recent advances in our knowledge of the morphologies of immature forms suggest that these life forms may play a very important role in studies on phyletics. Second-stage males of the nominal type species of various diaspidid tribes are described, and comparisons are made between them. Closely related species (based on adult females) in several genera (e.g., Chionaspis, Diaspis, Lineaspis, Odonaspis, and Quernaspis) are also compared in this stage, and differences are noted. The usefulness of the second-stage males as a tool in phyletics is compared with that of the adult females and first instars.

1W-5,4 THE NATURAL GROUPS OF THE GENERA OF THE MEALYBUGS (HOMOPTERA, COCCOIDEA, PSEUDOCOCCIDAE).

MacGregor-Loaeza, R. and Sampedro, G. (Instituto de Biología, UNAM, Ciudad Universitaria, México 20, D.F. México

Some ideas about the formation of natural groups among the genera of mealybugs are discussed, taking into account the works of Ezzat-McConnell (1956), who create the tribe Planococcini, that of Borchsenius (1958) who mention the tribe Antoninini and the book on Mealybugs of California by MacKenzie (1967) who present several grouping of genera but without any particular nomination. This project is under development analyzing by computer about 35 characters of 125 genera, and it is programmated to work with resemblance indexes (Pearson's correlation) that will show affinities and differences among all the genera included in the study.

1W-5,5 INTERPRETATION OF 2ND INSTAR MALE CHARACTERS IN THE SYSTEMATICS OF THE DIASPIDIDAE.

Takagi, S. (Ent. Inst., Hokkaido Univ., Sapporo, 060 Japan)

Sexual dimorphism in the diaspidid 2nd instar larvae considerably varies in the degree of differentiation and also in the type of difference. We have even some cases where the 2nd instar males are strikingly different among species which are obviously closely related so far as based on the female characters. These phenomena in the 2nd instar male characters may be explained by supposing the existence of more or less stable "prepatterns". The phenotypic suppression or manifestation of prepatterns must occur more or less suddenly, with no process of direct adaptive selection for itself, and entail parallelism and/or atavism. If this view is correct, the degree of resemblance among the 2nd instar males does not necessarily indicate the degree of phylogenetic relationship.

1W-6,1 FINE STRUCTURE OF TARSAL SENSORY ORGANS IN THE FORELEGS OF PROTURAN ACERENTOMON.

Dallai, R. and Nosek, J. (Inst. Zool., Siena Univ., Siena, Italy and Inst. Virol., Bratislava 9, Czechoslovakia)

In all Protura the forelegs have replaced the function of the missing antennae and are bent forwards over the head. Obviously many sensory receptors have developed on this region. The fine structure of the clavate sensillum t_1 is carefully examined. Three neurons innervate this sensillum but only two dendrites seem to penetrate inside the hair shaft to reach the distal enlarged part of the sensillum, where they branch. A dense tubular secretion from the tormogen cell extends through the fluid space surrounding the outer dendritic segment and then continues inside the numerous pore tubules to the external surface. The forelegs, as well as the tibia, also contain secretory cells which bind an extracellular cavity from which an efferent ductule starts towards the surface.

1W-6,2 GEOGRAPHICAL DISTRIBUTION OF POLISH ACERENTOMON (Protura)

SZEPTYCKI Andrzej, Inst. Syst. Exp. Zoology, Cracov, Poland

The distribution of 8species of Acerentomon is analised on the base of analogies with distribution of some vascular plants and some different invertebrates. The distribution is determined mainly by the historical and climatical factors.

1W-6,3 SYSTEMATICS OF PROTURA

Nosek, J. /Inst. Virol. SAS, Bratislava, 809 39 Czechoslovakia/

The present taxonomy of protura expresses to a some extent a rational system, i.e. system of nature. From practical point of view the rational system seems to be more acceptable than phylogenetical one. It is based on correlation between morphology, spatial distribution and habitat, anatomy, spermatology etc. I propose the following system:

Classis: Protura

Orders: Acerentomida Eosentomida

Suborders: Acerentomoidea Sinentomoidea Eosentomoidea

Families: Acerentomidae Sinentomidae Protentomidae Eosentomidae

Family Acerentomidae with untill known genera
Family Sinentomidae with genera Sinentomon, Hesperentomon, Huhentomon
Family Protentomidae with genera proturentomon, Condeellum, Hinomotentomon, Fujientomon, Protentomon
Family Eosentomidae: Eosentomon, Madagascarentomon, Anisoentomon, Antelientomon, Zhogguohentomon, Styletoentomon. Isoentomon

Phylogenetically, Protura, Diplura and Collembola can be considered as independent branches of Apterygota.

1W-6,5

ACERELLA COMPEX WITHIN ACERENTOMIDAE (PROTURA), A PHYLOGENETICAL CONSIDERATION. Imadaté, G. (Biol. Lab., Konodai Col., Tokyo Medical and Dental Univ., Ichikawa, 272 Japan)

The *Acerella* Complex includes in its members such genera as *Acerella, Acerentomon, Alaskaentomon, Filientomon, Imadateiella, Nipponentomon, Nosekiella, Verrucoentomon, Vesciculentomon, Yamatentomon* and son on, which flourish in the temperate region of the Northern Hemisphere.

An attempt to put these genera in their phylogenetical relations is to be made by a revised arrangement of generic characteristics in the members.

1W-7,1

ON THE GENUS *METAPHYCUS* MERCET IN THE ETHIOPIAN REGION

Annecke, D.P. and Mynhardt, M. Judith (Plant Protection Res. Inst., Pretoria, South Africa)

A study of *Metaphycus* has exemplified some taxonomic difficulties that are often encountered in the Encyrtidae. Through a misunderstanding, *Metaphycus* was for many years thought to be synonymous with *Aphycus* Mayr, and the limits of the genus have been subject to changing interpretations. The species of *Metaphycus* resemble each other extremely closely, necessitating the study of cleared, slide-mounted specimens as well as material mounted on cards. Some species can be determined with assurance only if both sexes are present. The study of long series of specimens from as wide a geographic and host range as possible may lead to difficulty in interpreting variation. Good examples are provided by *M. helvolus* and *M. stanleyi*. Approximately 75 species have been recognized in the Ethiopian region and it is likely that many more remain to be collected and described.

1W-7,2

THE MORPHOSPECIES AND THE BIOSPECIES: AN URGENT PROBLEM IN MICROHYMENOPTERAN TAXONOMY. Askew, R.R. (Dept. Zool., Manchester Univ., Manchester M139PL, England)

In Chalcidoidea are several taxa in which speciation processes are active, presenting the taxonomist with ranges of morphologically more or less similar, sympatric forms. The museum taxonomist relies upon the morphospecies concept which is objective but ignores sibling species that are morphologically similar but biologically different. Conversely, morphological disparity is not necessarily indicative of specific status; host-linked and seasonal polymorphisms both exist. In *Chrysocharis*, the series *laricinellae-nitetis-pentheus-nephereus* presents almost continuous morphological variation and species can be determined, using morphological criteria, with only about 90% confidence. Biological differences, however, support the species limits defined morphologically. *C. nephereus* has two morphological forms associated with different trees, but experimentally both will develop on the 'wrong' trees and reproductive isolation has not been established. *Pediobius alcaeus* exists as two apparently reproductively isolated forms which should be accorded specific status. One is bisexual, the other thelytokous, but no morphological difference can be found. Taxonomic procedure in these cases is discussed. The morphospecies concept is too rigid but to step beyond it could precipitate a plethora of names that are not usefully tied to type material. Further, equal taxonomic ranking of biospecies and morphospecies obscures relationships. Taxonomists must give careful thought to these problems and seek an approach that is acceptable to both museum taxonomist and field ecologist; one that does not impose on the next generation of microhymenopterists a similar burden to the one we inherited from the last century.

1W-7,3

RECENT ADVANCES IN ENCYRTID SYSTEMATICS WITH SPECIAL REFERENCE TO THE GENERA DESCRIBED BY A. A. GIRAULT. Gordh, Gordon (Division of Biological Control, Department of Entomology, University of California, Riverside 92521)

The historical development of the taxonomy of encyrtids, including higher classification-schemes, is reviewed. Systematic affinities with other chalcidoids is discussed. The 153 genera of encyrtids described by A. A. Girault from Australia are surveyed with synonymy and homonymy identified. Zoogeographical distribution of encrtids at the generic level is outlined.

1W-7,4

SIGNIFICANCE OF THE EXTERNAL MALE GENITALIA IN THE CLASSIFICATION OF INDIAN APHELINIDAE(HYM.: CHALCIDOIDEA). Alam,S.M. and Hayat,M.(Zool.Dept.,Alig.Musl. Univ.,Aligarh-202 001, India)

The significance of the components of external male genitalia has been looked into at generic and suprageneric levels of Indian Aphelinidae. *Aphytis* with phallobase, parameres, volsellae and aedeagus relatively well-developed, form the base of this study. Probable modifications involve loss or reduction or fusion of these components. On this basis it is suggested grouping of Indian genera into three broad groups (each group with two or more subgroups). Group I:Presence of all components (*Marietta*, *Centrodora*, *Eretmocerus*). Group II: Parameres reduced or absent (*Protaphelinus*, *Aphelinus*, *Mesidia*, *Euryischia*, *Euryischomyia*, *Promuscidea*, *Eriaphytis*). Group III: Volsellae absent and parameres reduced or fused or absent (*Coccophagus*, *Aneristus*, *Encarsia*, *Physcus*, *Coccophagoides*, *Azotus*, *Ablerus*). The suggested characters of the male genitalia have been tabulated along with some of the characters of the females used in classifying Aphelinidae. On this basis the following subfamilies are accepted: Aphytinae, Aphelininae, Eriaphytinae, Azotinae, Coccophaginae, Eriaporinae, Physcinae. A key is given to the Indian aphelinid genera based on the male genitalic characters.

Section 2.

Morphology and Embryology.

2S-1,1

NEUROHEMAL ORGANS IN ARACHNIDA AND MYRIAPODA. Juberthie-Jupeau, L. (Laboratoire souterrain du C. N. R. S., Moulis, 09200 Saint-Girons, France)

In Arachnida the individualization of neurohemal organs (n.h.o.) is in direct relation with the condensation of the nervous system. Arachnida is divided into 3 groups. -In the first (Opiliones, Ricinulei, Solifuge) the paraganglionic plates (p.p.g.) are the only n.h.o. They lie in the posterior part of the syncerebrum and anterior dorsal edge of the sub-oesophageal nervous mass neurilemma. -In the second (Scorpiones) the n.h.o. are presented by a retrocerebral complex i.e. the stomatogastric ganglia of Police in which secretory cells are associated with axon terminals. -In the third (Araneae, Amblypygi and perhaps Acari) both p.p.g. and retrocerebral complex are present. In the Araneides, this latter is the first organ of Schneider and a site of storage of neurosecretory product. The acari possess p.p.g. with secretory cells incorporated; this might be a remnant of the retrocerebral complex related to the great condensation of the nervous system. Pseudoscorpiones exhibit p.p.g.but the nature of the 1st retrocerebral ganglion is not exactly definite.

In Myriapoda the postcephalic neurosecretory pathway is present in all the 3 orders studied from this point of view. The simplest case is observed in Symphyla in which the cephalic glands or organs of Gabe are the only known neurohemal organs; they consist of axonal terminations. In Diplopoda all the species possess organs of Gabe similar in structure with those of Symphyla. Different n.h.o. can be observed: -the hypocerebral organs with secretory cells and extracellular neurosecretory product, -the sinus formations the structure of which is identical to those of hypocerebral organs, -the connective bodies which are formed by axon terminations of cerebral origin, -the commisural plates, n.h.o. lying under the perioesophageal communicating nerve neurilemma. In Chilopoda, the n.h.o. are the cerebral glands, the structure of which consist of axonal neurosecretory endings, glial cells and secretory cells.

2S-1,2

NEUROHEMAL ORGANS IN CRUSTACEA

Chaigneau, J. (Lab. Zool. & Biol. Cell., Univ. Poitiers, 86022 France)

Crustacea have been important in neurosecretion research, giving first observations in invertebrates in 1931. Later they played a great part in the creating of the neurohemal concept, with the study of the organ X-sinus gland complexe. Therefore, added with the fact that they are Antennata, a survey of their neurohemal organs is a good introduction for the study of these organs in insects.

The diversity of Crustacea and the very numerous observations, often lead to a fairly ambiguous nomenclature and unsolved problems of homology. Few works lead with neurohemal organs of Entomostraca. A sinus gland or an optic neurohemal organ are occasionally observed, but often the existence of neurohemal organs is not established. In all groups of Malacostraca, there is a paired sinus gland, linked with the optic lobes of the brain. In addition, Malacostraca with eyestalks, like Decapoda, bear two other kinds of neurohemal organs, the postcommissural organs attached to the tritocerebral commissure, and the pericardial organs. In Isopoda there exists, in the head, a paired lateral plexus.

With the electron microscope, more structural precisions are obtained, specially concerning granules, as well as observations which determine that structures, like the organ of Bellonci, do not belong in the category of neurosecretory-neurohemal organs.

The easiness of eyestalk ablations led to a great number of experiments on Decapoda. From these experiments and others, (for example the elective removal of the sinus gland in Decapoda and in Isopoda), the results show that the sinus gland hormones are involved in moulting, water regulation, glycoregulation, chromatic adaptation, ovary physiology, motoneurone activity, etc.

Many problems of homology between the neurohemal organs of Crustacea and those of the other Arthropoda, are not yet resolved.

2S-1,3

CEPHALIC NEUROHEMAL ORGANS IN INSECTA: COMPARATIVE ACCOUNT OF CORPORA CARDIACA AND THEIR NEUROSECRETORY MECHANISMS. Normann, T.C. (Inst. Gen. Zool., Copenhagen Univ., DK-2100 Denmark)

The literature on corpora cardiaca (CC) of Insecta is reviewed with emphasis on adult organs. The CC are considered both as neurohemal organs for brain neurosecretory (NS) cells and as endocrine glands with intrinsic secretory cells. The functions are mentioned, and comparison is made between CC of various insects in an attempt to relate structural variations to physiological needs. The relation between CC and aorta wall is considered. Ultrastructural studies of CC have provided evidence on (1) details of submicroscopic anatomy, (2) types of axon terminals and their granules, (3) hormone release (exocytosis), (4) the nature of the intrinsic cells, and (5) innervation. The CC is finally discussed as an object for studies of general aspects of neuroendocrine mechanisms.

2S-1,4

ROLE OF PERISYMPATHETIC ORGANS AND OTHER NEUROHEMAL ORGANS IN THE NEUROSECRETORY SYSTEM - Raabe M. (Lab. Insect Neuroendocr., P.&M. Curie Univ., Paris, France)

The insect neurosecretory system has long been interpreted as consisting of brain NSC and their storage and release site, the corpora cardiaca. However, recent investigations have demonstrated the important neurosecretory activity of the ventral nerve cord and the existence of a number of release sites of neurosecretory products. The chief ones are the conspicious perisympathetic organs, located around the sympathetic nerves near the ventral nerve ganglia. Other neurohemal organs constitute thin networks located close to some organs and quite far from the nerve ganglia. NSM may also be conducted by nerves directly to some organs where neuro-effector junctions are to be found. Thus the neurohemal system of insects is wide spread throughout the body and, in some cases, the blood may not play the major part in the diffusion of neurosecretory products.

2S-1,5

MORPHOLOGY AND EVOLUTION OF PERISYMPATHETIC ORGANS.

GRILLOT, J.-P. (Univ. Marien Ngouabi,Brazzaville,Congo)

The perisympathetic organs (P.O) show a very important diversity which has required to define morphological types. According to the degree of individualization of sympathetic nerves, these organs are classified into 3 basic types termed primitive, intermediate and evolved. In each of them, medio-transverse, median and transverse organs can be distinguished in respect to the P.O. position on the fibres of various sympathetic nerves. In addition, the primitive types agree with more or less obvious swellings on visceral nerves and the evolved types consist in slightly thickenings or only in discrete neurosecretory endings located under the neural lamella of somatic nerves or of ganglia. The distribution of types is investigated at each segmental level for all the species inwhich P.O. are described. A tentative of reconstitution of P.O. evolution is made from the data of ontogeny and comparative anatomy. This phenomenon seems parallel with insect phylogeny. The P.O. are primitive in the taxa wich are assumed to be primitive in some respects (Paleoptera, Blattaria, Isoptera, Neuroptera, Trichoptera). In the evolved taxa (Hemiptera, Coleoptera, Hymenoptera, Diptera), the P.O. are also evolved, but, if the order shows a large species diversity, the P.O. belong to the intermediate types or even to the primitive types.

2S-1,6

ULTRASTRUCTURE OF PERISYMPATHETIC ORGANS - Baudry-Partiaoglou N. (Lab. Insect Neuroendocr., P.&M. Curie Univ., Paris, France)

A comparative ultrastructural study of various perisympathetic organs (PO) was carried out in Dictyoptera Cheleutoptera, Dermaptera, Heteroptera, Hymenoptera and Coleoptera. This research served to distinguish between the median PO and the transverse PO.

The median PO show great uniformity. They are characterised by their globular shape and the lack of sinus. They are also distinguishable by having only one type of neurosecretory product. All the species possess more or less ovoid dense neurosecretory granules (170X200nm).

On the contrary, the transverse PO have a loose structure and their exchange area with the haemolymph is large. This occurs two ways : by neurosecretory fiber scattering along the nerves or by numerous and deep sinus, when the organ is thick. Almost all the PO contain at least 3 types of neurosecretory granules. These differences between median and transverse PO may correspond to different modes of action.

2S-1,7 PHYSIOLOGICAL ROLE OF PERISYMPATHETIC ORGANS - Provansal-Baudez A. (Lab.Insect Neuroendocr., P.&M. Curie Univ., Paris, France)

The problem of the physiological role of the insect ventral nerve cord can be approached by studying the activities of perisympathetic organ extracts. Some physiological data have been accumulated so far. The perisympathetic organs affect diuresis in two opposite ways according to the investigated species. They have an interspecific cardio-accelerating effect. They are capable of increasing oviduct contractions and oviposition. Finally, they do possess a true role in the regulation of adult tanning. Some tests, however, show negative results but they are of limited significance. It might be assumed that, in these cases, neurohormones are released from distal neurohemal organs or directly to neuroeffector junctions.

2S-2,8 EMBRYOLOGY AND POSTEMBRYONIC DEVELOPMENT OF MACHILIDAE AND LEPISMATIDAE (INSECTA:ARCHAEOGNATHA AND ZYGENTOMA)., Larink, O. (Zool. Inst., Techn.Univ., D-3300 Braunschweig, FRG)

The embryonic development shows the following specialities: In the beginning the primordium is extremely short and situated at the posterior end of the egg pole. A very active growth zone at the posterior end of the germ band forms the mesoderm. The blastokinesis is extensive. The amniotic cavity is lacking or remains open.The segmentation shows primitive characters: an acron and 6 head segments, 3 thoracic and 11 distinct abdominal segments.

During the postembryonic development the number of instars is undetermined. The ratio of body length to the length of terminalfilum and of body length to the length of the cerci enables the determination of instars. The pattern of bristles on cerci, terminalfilum, and ventral bristles combs is specific of each instar, the bristle pattern on the labial palps is also sex specific.

Differences in the embryonic development between the orders Archeaognatha and Zygentoma are: the lack of amniotic cavity and an open eavity respectively; the formation of blastoderm cuticle in the Machilidae, which shows specific characters; the structure of pleuropodia.

2S-2,9 EMBRYONIC MIDGUT EPITHELIUM IN INSECTS: ORIGIN, DEVELOPMENT, MORPHOLOGY AND FUNCTIONS. Mori,H.(Dep.Nat.Hist., Tokyo Metrop.Univ., Tokyo, 158 Japan)

Embryonic midgut epithelium(EmbMGE) in insects may be defined as the innermost cell layer of the embryonic midgut beginning at the oesophageal valve and ending at the pyloric valve and malpighian tubules; EmbMGE encloses yolk directly.

Comprehensive review on following several problems of the EmbMGE will be presented. They are: (1) Description and evaluation of two theories(Bipolar midgut rudiment theory and yolk cell theory) on the origin and development of the EmbMGE, (2) Histology and cytology of the EmbMGE, (3) Discussion on the functions of the EmbMGE based on the information obtained ultrastructurally, and (4) Prospects of the EmbMGE study for the future. Diversity in the methods of the EmbMGE formation between closely related insects, and the composite origin of EmbMGE that has been revealed in various insects, suggest that determination of the EmbMGE may be best interpreted as a purely physiological process. I also should emphasize that the role of syncytial yolk cell in formation of the EmbMGE is to be reconsidered intently.

2S-2,10

DETERMINATION OF HEAD AND THORAX IN THE EMBRYO OF SMITTIA SPEC. (CHIRONOMIDAE, DIPTERA). Kalthoff, K. (Dept. Zool., Univ. of Texas, Austin, TX 78712, U.S.A.)

The specification of the body pattern during embryogenesis is under control of cytoplasmic determinants which trigger differential gene expression in a spatial order. In chironomid midges, the development of head and thorax requires the activity of "anterior determinants"; inactivation of these components results in the development of the specific pattern aberration, "double abdomen". Head, thorax, and some anterior abdominal segments are then replaced by an additional set of posterior abdominal segments joined with reversed polarity to the original abdomen. Experimental techniques used to determine the nature, and localization of the anterior determinants include localized application of enzymes, irradiation with monochromatic UV light of different wavelengths, photoreversal, and microbeam irradiation of centrifuged embryos, together with electron microscopic and biochemical investigations. The data collected so far indicate that ribonucleoproteins in the cytoplasmic matrix of the egg function as anterior determinants. They appear to be localized near the anterior pole in newly deposited eggs, and seem to spread over the anterior half of the embryo during intravitelline cleavage. The activity of the anterior determinants is not required prior to blastoderm formation for normal development to occur. During blastoderm stages, they seem to direct the synthesis of region-specific proteins. For review, see Kalthoff, K. (1979) In: Determinants of Spatial Organization (Eds. Subtelny, S. and I.R. Konigsberg), Acad. Press, New York, pp. 97-126.

2S-2,11

PRODUCTION OF LOGITUDINAL DOUBLE MALFORMATION BY CENTRIFUGATION OR BY UV-PARTIAL IRRADIATION IN THE CHIRONOMUS SAMOENSIS EGG. Yajima, H. (Dept.Biol., Ibaraki Univ., Mito, 310 Japan)

There have been several investigations producing mirror image duplication of the head or the abdomen of the Chironomid embryo by centrifugation (Yajima, 1960; Gauss & Sander, 1966; Overton & Raab, 1967 ; Kalthoff, Hanel & Zissler, 1977) or by partial uv-irradiation (Yajima, 1964; Kalthoff & Sander, 1968; Kalthoff, 1971 - '79). However, the results of these investigations differ in some details. So, in the first section of this report, the results of these centrifugation experiments published so far will be compared. In the second section, a centrifugation experiment to search for a common basis lying in the different results will be described. In the third, since uv-irradiation experiment of the Smittia by Kalthoff gave rise to the duplication of the abdomen alone, an experiment of uv-irradiation of the Chrionomus inducing the duplication of the heads in a large number will be shown.

2S-2,12

HORMONES DURING EMBRYOGENESIS OF THE MILKWEED BUG, ONCOPELTUS FASCIATUS Dorn, A. (Inst. Zoology, Mainz Univ., D-65 Mainz, West Germany)

Ecdysteroids and juvenile hormone (JH) seem to play a decisive role during insect embryogenesis (Dorn, 1978). Ecdysteroids present during "early" embryonic development of Oncopeltus are obviously of maternal origin. Their titer remains about constant until katatrepsis, when it rises enormously. Three peaks parallel the deposition of three embryonic cuticles, and it is only during this "later" embryonic development that hydroxylation of ecdysone and characteristic metabolites of 20-hydroxyecdysone are observed. Application of exogenous ecdysteroids, i.e. makisterone A, accelerates embryogenesis. Similar to ecdysteroids, also the level of JH rises dramatically during katatrepsis. The possible role of JH was tested by application of the anti-JH, precocene II. This substance, known to cause inactivation and disintegration of active corpora allata, disturbs the dorsal closure (DC). Exogenous JH can prevent this defect, suggesting that DC is under the control of JH. Further investigations will have to show, to what extent embryonic development is directed by hormones.

2R-1,1

STUDIES ON THE RADIATION EFFECT OF THE OOGENESIS IN DACUS DORSALIS. Lee, Lena W.Y. and Hwang, S.M. (Inst. Zool. Academia Sinica, Taiwan, Republic of China).

Each ovary of cacus dorsalis consists of a cluster of tapering ovarioles. The ovarioles of this fly are the polytrophic type with an alternating successive of nurse cells and Oocytes. These cells are differentiated from anterior germarium and followed by a series developing an egg chamber. Each egg chamber contains 16 cystocytes which are produced by 4 divisions from a single Oogonium. The posterior cell of the 16 differentiates becomes an Oocyte, while the others serve as nurse cells nourishing the developing egg. The Oocytes and the nurse cells are surrounded by a single layer of follicle cells. While the full grown pupae are irradiated with 13 Kr. of Co^{60} r-ray. The ovaries appear much smaller than normal observed 6 days after emergence. The Oogonial metaphase and anaphase were absent, and many Oocytes were pycnotic degeneration and showed abonormalites. Light and electron microscopic examinations were used for these preliminary results.

2R-1,2

ANALYSES OF EGG ASSEMBLY USING A MUTANT OF BOMBYX MORI. Sakaguchi, B., Kawaguchi, Y., Fujii, H. and Koga, K. (Fac. Agric., Kyushu Univ., Fukuoka, 812 Japan)

For an understanding of the role of the presumptive embryo-proper regions in the ooplasm of B. mori, basic analyses about the egg assembly were carried out by using a mutant ki, whose eggs are kidney shaped due to a distortion received on the ventral side of an oocyte, the presumptive embryonic region. These eggs allow only incomplete ectodermal tissues to differentiate, and the embryos never hatch. The first approach was made by a scanning electron microscope. As to vertical and transverse sections through the center of an egg, the lengths of elliptic circumference at the ventral (V) and dorsal (D) sides were equal both in normal (control) and ki eggs, but slightly smaller in ki than in normal. The average number of follicle-cell imprints on an egg surface in ki was larger than in normal at both V and D sides as counted on vertical sections. However, the average area per unit imprint was ki < normal at V side while normal < ki at D side. These facts imply that the V-side follicle cells in a developing ovaries of ki are smaller in size and larger in number than those of normal. Our second approach was RNA distribution in the matured egg investigated cytologically. ^{3}H-uridine was injected into young female pupae, and after imagination eggs were collected, fixed, sectioned and autoradiographed. The grains distributed sharply along the periplasm of an egg. There were no difference between the normal and ki eggs. From the results it might be inferred that the deficiency of organogenesis in ki is related to the abnormal size and number of follicle cells close to the presumptive embryonic area of an oocyte. However, this distortion seems not to affect the deposition of bulk maternal RNA.

2R-2,3

NUCLEOLAR SIZE AND RIBOSOMAL RNA SYNTHESIS IN RELATION TO DIAPAUSE OF BOMBYX EGGS. Kurata, S., Koga, K. and Sakaguchi, B. (Fac. Agric., Kyushu Univ., Fukuoka, 812 Japan)

In the silkworm eggs, diapause occurs before the onset of organogenesis. Diapause is terminated after chilling for 3 months. We have studied nucleoli and rRNA synthesis during the activation of diapause by the long-term chilling and reported that the nucleolar size increases without a rise of rRNA synthesizing capacity at the early period of chilling (Kurata, Koga & Sakaguchi, J. Insect Phys., 25, 115, 1979). Further study was made about the pre-diapause and post-diapause periods of hibernating eggs, and the whole embryogenetic periods of non-hibernating eggs. (rRNA synthesis at the early period has been reported partly, cf. Kurata, Koga & Sakaguchi, Insect Biochem., 9, 107, 1979). In the non-hibernating eggs, nucleoli became detectable at 10 h after oviposition (syncytial blastoderm stage) and their size enlarged rapidly thereafter in parallel with the rRNA synthesis rate, both showing a peak at 30 h (early gastrula stage). In hibernating eggs, nucleoli also emerged at 10 h, but their size and the rRNA synthesis rate did not change significantly. After the complete activation from diapause by the long-period chilling, the burst of rRNA synthesis was immediately commenced; the nucleolar size and rRNA synthesis fell thereafter and never showed a peak. The overall developmental pattern was very similar to that after 30 h (early gastrula) of the non-hibernating eggs. These findings might suggest that the onset of diapause of silkworm eggs includes the process which retards the ribosome synthesis necessitated for organogenesis, and that the activation of diapause eggs in the low temperature involves the process which construct ribosome-synthesizing machinery to the level comparable to that at the early gastrula stage of non-hibernating eggs.

2R-2,4

EMBRYOLOGY OF THE PRIMITIVE MOTH, NEOMICROPTERYX NIPPONENSIS ISSIKI (MICROPTERYGIDAE: ZEUGLOPTERA) Kobayashi, Y., Ando, H. (Dept. Biol., Saitama Med. Sch., Kawakado, Moroyama, Saitama, 350-04 Japan)

Changes in external form of the embryo during development of N. nipponensis were shown and compared with those of other lepidopteran insects. The small circular germ disk deeply invaginates into the yolk, and the opening of the invagination then closes. The invaginated part finally separates from the rudimental serosa, and the sac-shaped germ rudiment is formed. Its anterior side later develops into the germ band, and the posterior one is the future amnion. Hence, the serosa and the amnion are formed simultaneously by the fusion of the amniotic folds. The formation of the germ rudiment and embryonic envelopes in N. nipponensis closely resembles those found in the eggs of swift moths or an annulipalpian caddisfly. In the species, just before revolution, the germ band assumes completely superficial position, carrying the yolk on its dorsum, whereas germ bands of all other lepidopteran insects are still immersed in the yolk in the same stage. Two embryonic membranes do not rupture during the revolution of the embryo like those of other Lepidoptera. After revolution, however, the membranes concentrate on the dorsal portion of the yolk, and they are taken in the yolk to form a secondary dorsal organ just before the completion of the dorsal closure, then degenerate. Such a structure is never observed in any other lepidopteran embryos in which the membranes are intact even after dorsal closure, however, a typical secondary dorsal organ is formed in the embryo of annulipalpian Trichptera. The close affinity between the Zeugloptera and the Trichoptera is supported by the present embryological evidences.

2R-2,5

EMBRYOGENESIS OF THE PLEUROPODIA AND THE ABDOMINAL FILAMENTS (TRACHEAL GILLS) IN PROTOHERMES GRANDIS THUNBERG (MEGALOPTERA: CORYDALIDAE). Miyakawa, K. (Gakushuin High School, Tokyo)

In P. grandis embryos existence of two pairs of appendages was found in the first abdominal segment. They are the pleuropodia and the rudiments of the abdominal filament (tracheal gill). Besides the latter was found topologically different from the corresponding pair of abdominal appendages of Panorpa pryeri embryos reported by Ando and Haga (1974) (Miyakawa, 1979). These facts may be interesting to conseder the homology of the abdominal legs (prolegs) with the thoracic legs in insect larvae.

The present study deals with histological observations of the abdominal appendages.

2R-3,6

THE TRITOCEREBRAL COMMISSURE, A MORPHOLOGICAL PROBLEM. Chaudonneret, J. (Lab. Biol. anim. & gén., Univ. de Dijon, 21100 Dijon, France)

There are two distinct tritocerebral commissures in many lower insects. Each of them unites a pair of nervous centres ; the two ipsilateral ones may be considered as belonging to two distinct neuromeres, namely the tritocerebron (s.str.) and the tetrocerebron.

In numerous insects, these two commissures are fused together ; in other insects , the tetrocerebral commissure has sunk into the suboesophageal ganglion. In both cases, only one free post-stomodeal commissure is observed. In other insects, finally, both commissures are incorporated into the suboesophageal ganglion.

Sometimes, when two commissures are seen, the anteriormost is nothing but a pseudo-commissure, that is to say a pure anastomosis between two symmetrical nerves.

2R-3,7 OBSERVATIONS ON THE PROXIMAL REGION OF THE MALPIGHIAN TUBULES OF INSECTS WITH FURTHER ANATOMICAL EVIDENCES ON THEIR PROCTODAEAL ORIGIN.

Murad, H. (Dept. Zool., Makerere Univ., Kampala, Uganda) and Mohamed, U.V.K. (Dept. Zool., Univ. Calicut, Calicut, India).

Proximal regions of Malpighian tubules of Spathosternum praciniferum Wlk., (Orthoptera), Laccotrephes maculatus Fabr., (Hemiptera), Mylabris pustulata Thunb., (Coleoptera), Calogramma festiva Donov., (Lepidoptera), Dacus cucurbitae Coq., (Diptera) and Vespa bicolor Fabr., (Hymenoptera) representing all the major orders of insects have been described. Their relationship with the alimentary canal has been discussed.

The Malpighian tubules in all the insects under study have been observed to attach with the alimentary canal close to the junction of the midgut and hindgut superficially but oblique longitudinal sections confirm their continuity with the hindgut, thereby suggesting proctodaeal origin.

2R-3,8 A PHYLOGENETIC PROCESS AND ORIGIN OF THE MESOPLEURON IN BUTTERFLIES.

Emoto, J. (Biol. Lab., Nanzan Univ., Nagoya, 466 Japan)

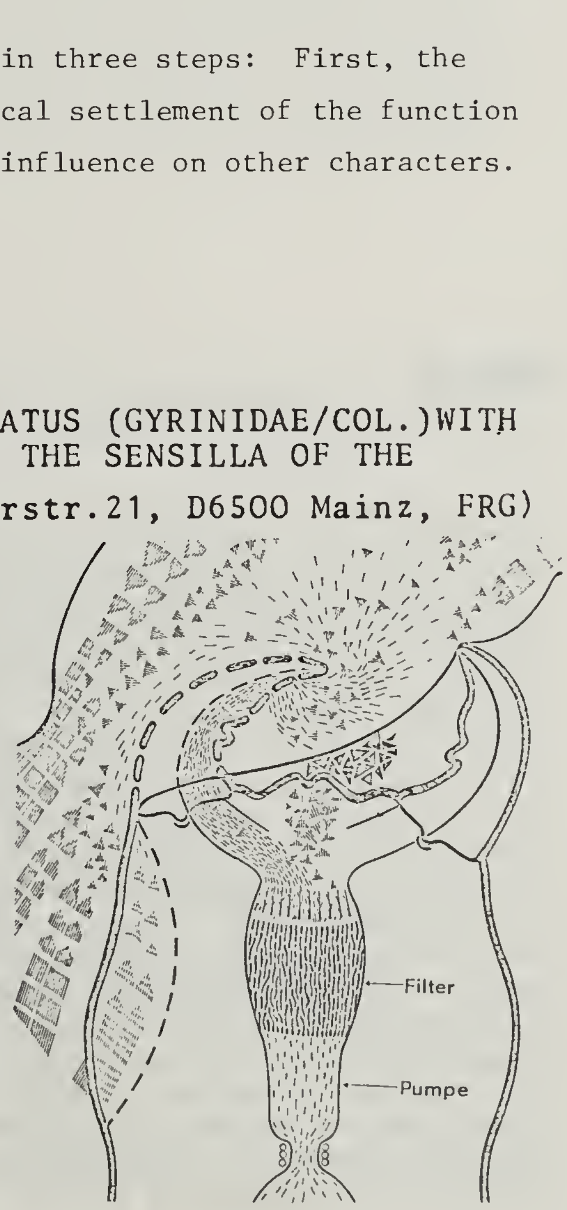
In Papilionoidea the derived condition of the mesopleuron is recognized in the following characters: Paracoxal suture partly reduced and reaching near the base of the wing process; muscle t-p 13 arising from the katepisternum; anepisternum and preepisternum reduced. The variation of these characters in each family represents a similar morphocline. This congruence of the morphocline is considered as homoiology, such that the shift of the origin of t-p 13 gives rise to the other derived condition. In many insects t-p 13 is one of the flexors of the wing (main-function) and probably one of the regulatory muscles of their flight (sub-function). In Papilionoidea, however, the sub is superior to the main as regulatory function. Furthermore it is assumed that the origin of t-p 13 was shifted morphologically so that the sub-function superseded the main function.

In conclusion, the phylogenetic process of the mesopleuron occurred in three steps: First, the superiority of the sub-function (preadaptation); second, the morphological settlement of the function (aromorphosis); and finally, the strengthening of the function and its influence on other characters.

2R-4,9 THE NOURISHMENT OF THE LARVAE OF GYRINUS SUBSTRIATUS (GYRINIDAE/COL.)WITH REFERENCE TO THE FINESTRUCTURE OF THE FILTER MECHANISM AND OF THE SENSILLA OF THE ANTENNAE.

Rupprecht, Rainer (Inst.f.Zool.,Joh.-Gut.Univ., Saarstr.21, D6500 Mainz, FRG)

Gyrinus larvae take up their food by puncturing the prey, injecting digestible enzymes and sucking and filtering the fluid. The filter mechanism is described and demonstrated with fotos (of light and scanning microscop) and pictures. In connection with this the ongoing of nourishment is discussed. Finally there is given a description of the finestructure of the sensilla of the antennae. With these sensilla the larvae contact and verify their prey firstly.



2R-4,10

FINE STRUCTURE OF THE RETINA OF THE SCARABAEID BEETLES. Gokan, N. (Lab. Ent., Tokyo Univ. of Agr., Tokyo, 156 Japan)

The compound eyes of the scarabaeid beetles have already been distinguished into four types by the light microscopic observation on 52 species in Japan (Gokan, 1973). The retinal fine structure of each type eye was studied using an electron microscope on some representative species.

Type 1.-- The eyes of this type are of the "apposition type". Hopliinae, several diurnal species of Rutelinae and Glaphirinae belong to this type. Relatively small "fused rhabdom" is located in the central part throughout the retina. Type 2.-- This type is found in diurnal species such as *Maladera orientalis* and *Paraserica grisea* of Sericinae. It is presumably of the intermediate type between the "apposition" and the "superposition" types. Short, and not so fine, clear zone is observed near the distal part of the retina. The rhabdom is separated into two part, above and below this zone. The distal rhabdom is small. This feature resembles to that of diurnal species. On the contrary the proximal one enlarges toward the middle part, and is composed of V-shaped rhabdomeres. This feature is found in nocturnal species. Type 3.-- This type is found in Cetoniinae, Valginae and *Popillia* of Rutelinae, all of which are diurnally active. Although the retinal form is apparently of the "superposition type", no migration of the nuclei occurs in dark-light adaptation. The rhabdom is complicated in arrangement at the middle part, whereas at the proximal part, six rhabdomeres are arranged as ring-like pattern in the cross section. Type 4.-- This is of the typical "superposition type", or clear zone eye, found in Melolonthinae, nocturnal Sericinae and diuro-nocturnal Rutelinae. The configuration of the rhabdom is similar to that of nocturnal moths. In *Maladera castanea*, which is entirely nocturnal species, the rhabdom largely occupies in the proximal part of the retinula cells.

2R-4,11

ON THE TARSAL MICROSTRUCTURES OF SOME CHALCIDOIDEA (HYMENOPTERA)

Domenichini G. (Istituto di Entomologia, Facoltà di Agraria, Piacenza)

Studies with the Scanning Electro Microscope of tarsi of some Chalcidoidea belonging to various families reveal the importance of these appendages for the exploration of the substratum and for carrying out other vital functions.

In particular, reference is made to some structural characteristics of the pre-tarsus which show its correlation with the ecology and ethology of the species.

2R-4,12

ROLE OF AIR CIRCULATION THROUGH THE TRACHEAL SYSTEM OF *PERIPLANETA AMERICANA* (L.) IN THERMAL ADJUSTMENTS. *TONAPI, G.T.* (Dept. Zool., Poona Univ., Poona 411007 India)

The oxygen uptake in the thoracic muscles of active insects is as much as 8.0 ml/gm/min. at NTP which represents an unparalleled steady-state record surpassed only by freely suspended bacteria (Weis-Fosh, 1961 and 1964). In spite of similar examples of heat generating mechanisms very few attempts have been made in insects to correlate the comparative role of spiracles, tracheae, ventilation volume with parallel studies on oxygen consumption, effect of ambient temperature and thermal adjustments. For this purpose, well known model of *Periplaneta americana* (L.) has been chosen. The spiracular area, tracheal bore and volume and the rate of air flow through them have been measured. About 50% of air volume ventilates the thorax while the remainder circulates through the abdominal region. When the total air circulation at different temperatures was compared with oxygen consumption, the air intake was found to increase excessively more than the expected values. Amount of air intake/min. through the spiracles continues to increase out of proportion with increase in temperature even though oxygen consumption falls after 38°C. Thus, the observed values of amount of air intake are much more than the expected values of air intake. It has been hypothesised that required air constitution for diffusion at any temperature is brought by temperature dependent respiratory stimulants that introduce several times greater quantity of air to buffer the lethal effects of high temperature. It is suggested that this forced air circulation through tracheal system of various heat generating body compartments acts as a coolant to bring about thermal homeostasis - very much as an air cooled engine, in which convective forces are utilised for heat exchange.

2P,1 BRUSHES, SETOSE DEPRESSIONS AND CRIBRIFORM PLATES - WHAT ARE THEY FOR?

D.G.H. Halstead. (Slough Laboratory, Ministry of Agriculture Fisheries & Food, U.K.)

Secondary sexual characters are well known in male beetles. Horns may occur, antennae are sometimes different, legs are often modified for gripping and tubercles or ridges may be present on abdominal sternites. Apart from these characters there are little known, usually ventrally situated, depressions, pits or raised areas each bearing pores or groups of pores (cribriform plates). In addition, these areas are usually setose and the setae may form a brush. Such structures may occur on the head, thorax or legs but are most frequently situated on the sternites of the abdomen. They are found in many beetle families, either throughout a genus or restricted to particular species, e.g. in Bruchidae, Ciidae, Coccinellidae, Dermestidae, Erotylidae, Ptinidae, Tenebrionidae and Trogossitidae. Histological examination of some examples has shown that secretory cells are associated with these structures and there is evidence which suggests that they may be sites of pheromone production and release. Much work remains to be done.

2P,2 OVARIAN STRUCTURE AND OOGENESIS IN THE IDOLOTHRIPINE THRIPS, BACTRIDOTHRIPS BREVITUBUS (THYSANOPTERA : PHLAEOTHRIPIDAE)

Haga, K. (Inst.Biol.Sci.Univ.of Tsukuba, Sakura-mura,Ibaraki,305 Japan) and Matsuzaki, M. (Lab.Biol.Fukushima Univ.)

A pair of ovaries of Bactridothrips brevitubus consists of each four panoistic ovarioles. The distal part of the ovarioles coalesces each other and forms a common germarium which irregularly contains several oogonia, young oocytes and prefollicular cells. Each ovarioles has 10-14 ovarian follicles with well-developed interfollicular tissues. In the previtellogenic region an enlarged germinal vesicle contains a large mass of granular nucleoli within, and the nucleolar emission is distinct. In the vitellogenic oocytes each two mycetom globules are formed by numerous small oval organisms which vary in size ranging 0.8 to 2.6 μm long. The organism also can be found in the germarium. Some basophil spherules appear near the posterior pole in almost matured oocytes, and they form a disk-like pole plasm. Vitelline membrane and chorion are formed just before ovulation. When many ovoviviparous eggs are stored in lateral oviducts, the posteriomost oocyte of each ovariole is often reabsorbed by follicular cells and finally forms a corpus luteum-like plug.

2P,3 Comperative structural and functional studies of the jumping mechanism and the abdominal nervous system in Collembola.

Brauner,U., Christian,E., Schaller,F., Inst.f.Zool., Univ. Vienna (Austria).

Collembola differ from other apterygote insects not only in the possession of the "furca" but in their abdominal nervous system. Our studies were concerned with these two characteristics:
a) mechanism and course of the jump
b) cross and fine anatomy of abdominal ganglia and nerves.
Jump analyses were made by means of high speed shootings and stroboscopic pictures. In contrary to MANTON (1972), direct muscle and not hydraulic action play the dominant part in jumping.
In all Collembola abdominal ganglia are concentrated either in the third thoracic segment or in the first abdominal segment. The differences in ganglia concentration and nerve bifurcation suggest an increasing derivation from Anurida and Neanura to Hypogastrura and Onychiurus and finally to Isotoma and Tomocerus.

2P,4 Correlations between the pattern of microvilli and the texture of chitin-containing microfibres during formation of peritrophic membranes.

Peters, W., and D'Haese, J. (Inst. Zool., Duesseldorf Univ., D-4000 Duesseldorf, F.R. Germany)

Hexagonal and orthogonal textures of chitin-containing microfibres have been found only in peritrophic membranes (PM). Mercer and Day assumed already in 1952 that the arrangement of microvilli is responsible for these patterns of microfibres; this in only possible if the polymerisation of microfibres takes place between the microvilli. The hypothesis has been controversial. However, in some species the polymerisation of microfibres occurs already at the base of extremely long microvilli and microfibres as well as their dimensions were compared, and in negative staining preparations the course of single microfibrils was followed in the bundles of microfibrils. In this way the hypothesis of Mercer and Day has been verified.

2R-2,13 REGRESSIVE SPERMIOGENESIS IN INSECTS. Baccetti, B. and Dallai, R. (Institute of Zoology, University of Siena, Italy)

As a consequence of the acquisition of an extremely sophisticated inner fertilization and of egg micropiles, in highly evolved insect groups the spermatozoa frequently lacks motility, and namely acrosome, centrioles, axoneme, mitochondria, accessory bodies or even all these organelles have disappeared. The process of spermiogenesis reveals traces of this fate, and different levels of regression can be distinguished. Examples are taken from Protura, Isoptera, Phasmoidea, Aleyrodid or Coccid Homopterans, Psychodid or Cecydomyid Dipterans. As mitochondria, centrioles or other organelles already present in spermatid are concerned, they are eliminated with big portions of cytoplasm or reabsorbed by lysosomal activity; acrosome or accessory bodies are not formed and the activity of the Golgi complex is completely absent or limited to the production of ample vesicles extruded from the cytoplasm; the axoneme is firstly produced and after disrupted in some cases, not produced at all in others; the manchette, usually disappeared in mature sperm, is conserved when motility is regained in absence of axoneme.

2P,6 Fine structure and permeability of peritrophic membranes of Diptera.

Peters, W. (Inst. Zool., Duesseldorf Univ., D-4000 Duesseldorf, F.R. Germany)

It has been shown that in a large number of Nematocera larvae a single peritrophic membrane (PM) is formed, whereas in flies there is a tendency to secrete up to three structurally different PM; all are formed as continuous tubes. Nutritive substances have to penetrate this tube before they reach the midgut epithelium. The permeability of PM has been investigated in 10 species by a feeding marker substances as dyes, hemoglobin, cytochrome C, horseradish peroxidase and especially FITC marked dextran fractions. The PM of Aedes aegyptilarvae was least permeable, only for molecules of Mw <2400 daltons. Molecules larger than 40.000 daltons did not permeate the PM of the species which were investigated; a correlation between structure and permeability properties has not been found. The results will be compared with the permeability properties of other membraneous structures.

2P,7

A THEORETICAL MODEL OF NUCLEAR MIGRATION OF SUPERFICIAL CLEAVAGE.

Doi,H.(Dept. Biophysics, Kyoto Univ., 606 Japan)

A flattened blastomere of sea urchin egg has, at interphase, its nucleus at the position of the maximum point of the 1st mode of the Helmholtz-type equation $(\partial^2/\partial x^2+\partial^2/\partial y^2)u=-\lambda u$ (u=0 on the cell boundary)···eq.(1); at mitotic phase it divides along the nodal line of the 2nd mode of eq.(1); where the i-th mode of eq.(1) is the appearance of the eigenfunction for the i-th eigenvalue of eq.(1) (to appear). A flat culture cell also generally has its nucleus at the position of the maximum point of the 1st mode of eq.(1) in regard to it (unpublished). From these facts, a theoretical model is constructed under the following hypotheses: The egg has the layer of periplasm and the cytoplasmic network which is set up in the whole egg; each dividing nucleus has the cytoplasmic iland around it whose volume is constant for each nucleus; this cytoplasmic iland is furnished at karyokinesis from a part of the cytoplasmic network which is the separation trace of the two daughter nuclei. These hypotheses are essential to the nuclear migration. Moreover we assume the unvisible division plane which is formed between the two daughter nuclei at karyokinesis. The model is: At first there is a nucleus at the center of the egg; we solve eq.(1) in regard to the egg numerically; at karyokinesis the two daughter nuclei are separated to the maximum and the minimum points of the 2nd mode; the unvisible division plane is formed along the nodal line of the 2nd mode; a part of the cytoplasmic network between the two nuclei turns into their cytoplasmic ilands; then two new areas are defined; we solve eq.(1) separately with regard to each new area; the position of each nucleus agrees with the position of the maximum point of each 1st mode at interphase; each nucleus is separated to the maximum and the minimum points of each 2nd mode at karyokinesis. Repeating this procedure, the dividing nuclei migrate to the egg surface.

2P,8

BLASTODERM FORMATION IN THE SILKWORM EGG (*BOMBYX MORI* L.).

Takesue, S. and Keino, H. (Biol. Inst., Facul. Sci., Nagoya Univ., Nagoya 464, Japan)

Blastoderm formation in the egg of silkworm, *Bombyx mori* L. was investigated by light and electron microscopies. In *Bombyx* eggs blastoderm cells seem to be formed in a mechanism different from that usually observed in many other insect species; that is, in *Bombyx* eggs no typical cleavage furrows were observed. Cleavage nuclei accompanied by the protoplasm migrated to the egg surface and pushed up the plasma membrane. Further, they continued their migration and protruded beyond the level of the periplasm to yield a blastoderm cell. Morphological features of intracellular organelles in the protoplasm of cleavage nucleus were also investigated during blastoderm formation.

2P,9

HISTOCHEMICAL AND ELECTRON MICROSCOPIC STUDIES ON DIFFERENTIATION OF COCKROACH (*PERIPLANETA AMERICANA*) FLIGHT MUSCLES.

Aizu, S. (Dept. Anat., Tohoku Univ. Sch. Med., Sendai 980 Japan & Rutgers Med. Sch.-CMDNJ, Piscataway, NJ 08854 USA)

Flight muscles (177C numbered by Carbonell, 1947) in different developmental stages (nymphs 15 and 30 mm in body length, and adult) are investigated for histochemical activity, such as myosin-ATPase and succinic dehydrogenase(SDH), and for electron microscopic structure.

15 mm nymph. The 177C muscle of this stage shows low myosin-ATPase(+) and SDH(+) activities. Myofibrils average about 0.4 μm in width. Each myofibril is surrounded by an extensive network of sarcoplasmic reticulum. Neuromuscular junctions and tracheoles are distributed on the sarcolemma. Regarding myofilament array, one thick filament is surrounded by ten to twelve thin filaments.

30 mm nymph. SDH activity of the muscle becomes higher(++), whereas its myosin-ATPase activity remains low(+). Except an increase of mitochondria in number, electron microscopic features of the muscle fiber are similar to those in the 15 mm nymph.

Adult. Both SDH and myosin-ATPase activities are highest(+++) in the adult. Fine branches of the tracheal system penetrate sarcoplasm to ramify within the fiber. Abundant mitochondria are packed between the fibrils. The distribution of sarcoplasmic reticulum and T-tubules is fundamentally unchanged, whereas the myofilament array is drastically changed so that six thin filaments surround a thick one.

(Supported by the grant #244014 from Ministry of Education, Science and Culture in Japan, GRS #05576 and NIH #NS-067762 in USA.)

2P,10 LOCALIZATION OF LUCIFERASE IN FIREFLY PHOTOCYTE GRANULES. Neuwirth, M. (NIH, Bethesda, Maryland 20205 U.S.A.)

Photocytes, the light producing cells of the firefly light organ, are characterized by the presence of two types of granules. Small, "differentiated zone" granules, approximately 0.1-0.2um in diameter occur near the cell membrane, interspersed with mitochondria. These granules usually have an electron-lucent or flocculent core surrounded by a narrow band of electron-dense material just inside the granular membrane. Most of the photocyte cytoplasm is filled with 1-2um in diameter photocyte granules. In Photinus pyralis, the photocyte granules consist of a very dense crystal embedded in a less dense matrix. Periodicity in these crystals was measured by optical diffraction. In addition, tubules are often closely associated with the crystals. Some granules contain bundles of 2-4 tubules interspersed in a matrix but no crystals. Photuris versicolor photocyte granules contain a core of dense material in a matrix as well as a bundle of several tubules. Luciferase, the enzyme that catalyzes the light reaction has been assumed to be present in these granules. We raised antibodies to purified Photinus luciferase in rabbits. Immunodiffusion of antisera against purified luciferase from Photinus shows that we have a single species of antibody. Immunoperoxidase application to light organs after treatment with H_2O_2 to remove endogenous peroxidase shows that Photuris and Photinus enzymes are closely related and that luciferase is present in photocyte granules but not in "differentiated zone" granules or other parts of the light organ. The role of the granules in the light reaction will be discussed.

2P,11 ILLUSTRATIVE TECHNIQUES FOR REPRESENTING MORPHOLOGY OF APOTOMIS (TORTICIDAE: LEPIDOPTERA). Adamski, D. and Peters, T. Michael. (Dept.Ent. Univ.Mass. 01003,U.S.A.)

In preparing a generic revision of Apotomis the morphology of a "typical" species was studied. A number of illustrative techniques were attempted to determine how each could be most effectively used. Visuals include schematic and diagnostic drawings, scanning electron microscopy and three dimensional models.

Section 3.

Physiology and Biochemistry.

3S-1,1 TEMPORAL ORGANIZATION OF REPRODUCTIVE BEHAVIOR IN CRICKETS.

Loher,W. (Dept.Ent.Sc.,Univ.California,Berkeley,Cal 94720,U.S.A.)

Circadian timing of reproductive behavior operates on two levels: a) Intraindividual behavior patterns of mutually exclusive function are spaced out across the 24-hour period, and cooperative patterns appear in concert or sequence. b) Complementary interindividual behavior serving to bring the sexes together for mating are released in both sexes simultaneously. In the cricket Teleogryllus commodus, the circadian control of five behavior patterns and their temporal modification by environmental zeitgebers is demonstrated. The duration of mating cycles follows a daily rhythm suggesting circadian influence.- Cold nights suppress ♂-calling and ♀-locomotion and both behaviors shift together to the warmer daytime. Low temperatures do not directly cause this switch from nocturnal to diurnal activity, but they affect the biological clock.

3S-1,2 FUNCTIONAL ANALYSIS OF DIPHASIC CIRCADIAN ACTIVITY OF THE MOSQUITO.

Chiba,Y. (Biol. Inst., Yamaguchi Univ., Yamaguchi, 753 Japan)

One circadian cycle often comprises multiple peaks. The mosquito Culex pipiens molestus, a main material here, may be a representative animal showing the diphasic circadian activity. 1) 'Morning'(Pm) and 'Evening' peak(Pe) respond in the respective way to the change of LD ratio or the phase shifting of 24-h LD cycles. Pm is lowered and phase shifted by lowering the constant level of temperature, say from 25° to 15°C which however, seldom affects Pe. These facts suggest that the two peaks are of physiologically different nature. The differential effect of temperature upon Pe and Pm may be taken as an evidence for a mechanism of seasonal adaptation involved in the diphase. 2) Particular LD ratios such as LD 22:2 yielded a beat from which two rhythmic components of circa-semi-dian were significantly detected - one synchronizing with LD and the other free-running, indicating the possibility that multiple oscillations differing in synchronizability with LD exist. Relationship between the findings 1) and 2) remains to be investigated. 3) Species specificity will also be discussed on the basis of data obtained for the subspecies C.p. pallens and the other five species.

3S-1,3 Time measurements in emergence of marine insects.

Neumann, D. (Dept. Zool., Univ. Koeln, FRG)

The timing of emergence in short-lived chironomids (Clunio) from intertidal habitats may be determined by two internal timing mechanisms controlling different developmental events, (1.) a semimonthly-lunar (semilunar) clock mechanism for the initiation of pupation every two weeks (in relation to the cycle of spring and neap tides), and (2.) a daily clock mechanism for eclosion at a distinct time of day (in relation to the low water time). Recent results on physiological components of the timing mechanisms will be presented. Referring to (1.), a circadian range of entrainment for the perception of the semilunar zeitgeber (a phase relationship between the 24 h light-dark cycle and a tidal stimulus) demonstrating a circadian clock component within the semilunar mechanism. Referring to (2.): comparison of circadian stocks from a semilunar population (North Sea) and a non-semilunar one (Baltic Sea) demonstrating different phase controls by the light-dark ratio of the photoperiodic zeitgeber. Experiments with the chironomid Thalassomyia revealed the lack of strong semilunar and daily timing of emergence in a long-lived species from the upper intertidal zone.

3S-1,4 PHOTOPERIODIC TIMING MECHANISM OF THE MATING BEHAVIOR OF A NOCTUID MOTH: ROLE OF HOURGLASS AND CIRCADIAN OSCILLATORS.

M. Sasaki (Lab. Entomol., Fac. Agricult., Tamagawa Univ., Tokyo, 194 Japan)

Mating behavior of the cucumber looper moth, *Anadevidia peponis*, is gated strictly at a specific time of night: the timing is a function of the photoperiod (Sasaki 1975, 1977). The evidence for a photophase-measuring function was obtained by varying the length of photophase given only once to DD individuals. The time (hr) from a light-off till the beginning of calling (sex pheromone releasing), f(x), was expressed as $f(x) = 11.1 - 2.5 \log x$ ($600 > x > 0.5$), where x is the length of photophase. This photophase-measuring clock was of an hourglass type and had no oscillatory nature.

The moth was found to have two circadian oscillators. One, called "Dusk Oscillator (DO)", began to oscillate with the light-off signal and seemed to elicit calling when a certain phase point was reached. The other, called "Master Oscillator (MO)", oscillated irrespective of photo- and scotophases and its phase did not shift easily. The calling time in LD condition seemed to be controlled in the following way: DO begins to oscillate from various phase points on the ascending slope of its oscillation; this phase point is determined by the preceding photophase through the titer of hypothetical substance accumulated during the photophase-measuring hourglass process. A kind of "conditioning " was also implicated in determination of the phase relationship of DO.

These findings were compared with known behaviors of the insect clocks.

3S-1,5 CIRCADIAN RHYTHMS AND PHOTOPERIODIC TIME MEASUREMENT IN Ostrinia nubilalis.

Skopik, S. (School of Life and Health Sciences, University of Delaware, Newark, DE 19711 USA)

The European corn borer, Ostrinia nubilalis, has been used extensively in studies of the photoperiodic clock (Beck, 1962, 1974ab, 1975, 1976ab, 1977; Bonnemaison, 1978ab; Skopik and Bowen 1976). Both induction and termination of larval diapause are under photoperiodic control. Although Beck's Dual System Theory (DST) makes certain predictions about overt circadian rhythmicity in Ostrinia, to date a rhythm has not been systematically studied in this species. The basic features of the oviposition rhythm, especially entrainment to non-24-hour light cycles, will be presented and compared with the Drosophila, Pectinophora, and Sarcophaga systems and the DST predictions. The ability to induce larval diapause in non-24-hour light cycles, including a discussion of the light and dark requirements, will also be presented.

3S-1,6 CIRCADIAN ORGANIZATIONS AND THE PHOTOPERIODIC PHENOMENA.

Colin S. Pittendrigh, Hopkins Marine Station of Stanford University, Pacific Grove, California 93950 USA

Analysis of the circadian system gating eclosion events in Drosophila pseudoobscura shows that in addition to the pacemaker driving the system there is a second, slave oscillator that is directly responsible for the gating signal. The phase-relation between the gating oscillator and its pacemaker is labile: it is subject to genetic change by selection; it is temperature dependent; and it changes with change in photoperiod. The argument is developed that the temporal program of a metazoan circadian organization is based on a central pacemaker driving many slave oscillators: variation in their free-running period and damping coefficients causes different slaves to have different phase-relations to their common pacemaker and hence to each other. The sequence of slave phases is the basis of the temporal (circadian) program which is subject to seasonal distortion as photoperiod changes. The phenomena of photoperiodism - including cases of temperature dependence and independence, and the existence of "circadian surfaces" - are all compatible with this concept of circadian organization.

3S-1,7 CIRCADIAN ENTRAINMENT AS A BASIS FOR TIME MEASUREMENT IN THE INSECT PHOTOPERIODIC CLOCK. Saunders, D.S. (Dept. Zoology, University of Edinburgh, Edinburgh EH9 3JT, U.K.)

Photoperiodic induction of pupal diapause in the flesh-fly Sarcophaga argyrostoma is a function of the circadian system. Although unequivocal confirmation is still lacking, the properties of this clock are best described by the External Coincidence model (Pittendrigh, 1966). Using the rhythm of pupal eclosion as overt 'hands of the clock', data from single pulse resetting experiments have been used to analyse photoperiodic night-length measurement in terms of this model. Excellent agreemant between prediction and observation has been obtained in a wide range of complete and 'skeleton' photoperiods. In a slightly modified form, the model also explains features such as the lowered incidence of diapause in ultra-short photoperiods and continuous darkness, if the rate of entrainment to 'weaker' pulses and the possible damping of the circadian oscillation in darkness are taken into account.

3S-1,8 PHOTOPERIODIC REACTION: OSCILLATOR AND HOURGLASS. Hidaka, T. (Dept. Zool., Kyoto Univ., Kyoto, 606 Japan) and Yamashita, K. (Ent. Lab., Kyoto Prefectural Univ., Kyoto, 606 Japan)

Time measurement in the photoperiodic reaction has been long subject to active discussions and several interesting hypothetical models are so far proposed. One of them is the external coincidence model which presupposes some light-sensitive points programmed at definite and fixed phase(s) of the circadian oscillation. The series of double light-interruption experiments carried out in the swallowtail, Papilio xuthus, demonstrated, however, that the effect of light-interruption is not strictly bound with the phase of circadian oscillation but largely depends on the length of preceding dark and light periods. This strongly suggests that some event of hourglass type is inseparably involved in the photoperiodic reaction, being superimposed on the oscillator-type time measurement.

3S-1,9 INTERACTION BETWEEN LIGHT AND TEMPERATURE CYCLES IN THE TIME MEASUREMENT FOR DIAPAUSE PROGRAMMING BY THE INDIAN MEAL MOTH. Kikukawa,S. and Masaki,S. (Lab. Ent., Hirosaki Univ., Hirosaki 036 Japan)

The Indian meal moth responds to a 'short-day' thermoperiod by entering diapause and to a 'long-day' one by averting it both in LL and DD. The critical thermophase lies at about 15 h, being about 1 h longer than the critical photophase. When temperature cycles (period=24 h, amplitude=10 C between 20 and 30 C) of different patterns, i.e., square-wave, trapezoid, symmetric and asymmetric triangular cycles, are superimposed on LD cycles inducing diapause, diapause tends to be averted by particular phase angles between the two environmental cycles. In most cases, this response can be accounted for by 'skeleton night' which may be formed by a particular phase point in the temperature cycle with either light-on or light-off. Therefore, the temperature change can be taken either as a dawn or as a dusk signal. Temperature rise following the temperature minimum seems to be more effective as a time cue than temperature fall. From these results, it is inferred that the clock mechanism programming the induction and prevention of diapause measures the time interval between two signals rather than the duration of a particular level of environmental factors such as light or temperature.

3S-1,10 PHOTOPERIODIC TIME MEASUREMENT OF PYRALID MOTHS.

Takeda, Makio (School of Life and Health Sciences, University of Delaware, Newark, DE 19711 USA)

Although the definite involvement of the circadian oscillation in photoperiodic time measurement in Hymenoptera and Diptera has been reported (Saunders 1974, 1978), hourglass time measurement seems more prevailing especially in Lepidoptera. As an attempt to understand the phylogenetic relationships of these mechanical priniciples, time measurement in three species of pyralidae will be reported and compared with each other, with a special emphasis on Diatrea grandiosella, where a double hourglass mechanism has been proposed (Takeda 1978). Plodia interpunctella is another species where hourglass characteristics have been shown (Takeda & Masaki 1975). In the case of Ostrinia nubilalis, the situation is still controversial but again hourglass characteristics have been shown (Skopik & Bowen 1976). Some general and specific findings in these species will be discussed.

3S-1,11 HOURGLASS PHOTOPERIODIC TIMING IN APHIDS. Lees, A.D. (Imperial College, Ascot, Berks, UK)

Photoperiodic time measurement in the aphid Megoura is accomplished by means of a non-circadian dark period hourglass which 'runs out' at the critical night length and which includes an early light-reversible stage. In the pea aphid Acyrthosiphon pisum two photoperiodic responses are found in the same individual. The first, controlling the production of oviparous and virginoparous females, resembles the comparable system in Megoura; the second, which regulates the production of male and female embryos also functions as a scotophase hourglass, but in other respects is entirely dissimilar. The peaked response to night length, the differing value for critical night length and the non-reversibility of the dark response are conspicuous features. It is concluded that the two timers are separate entities.

3S-1,12 PHOTOPERIODIC DETERMINATION OF DIAPAUSE IN THE SPIDER MITE TETRANYCHUS URTICAE

Veerman, A. (Lab.Exp.Entomol., Univ.of Amsterdam, Amsterdam, The Netherlands)

Evidence for the functional involvement of carotenoids in the photoperiodic induction of diapause in spider mites was obtained in genetic experiments with pigment mutants in which the uptake and oxidative metabolism of β-carotene is disturbed. Minimal amounts of carotenoids of maternal origin probably suffice in the embryo for the formation of a photopigment concerned in the photoperiodic induction of diapause. To study photoperiodic time measurement in spider mites diapause incidence has been determined in large series of experiments with asymmetrical and symmetrical skeleton photoperiods. Asymmetrical skeleton photoperiods with main photophases of from 9 to 13 h produced two peaks of long-day effect, whereas with main photophases of less than 9 h duration only a single peak of long-day effect was observed. Symmetrical skeleton photoperiods with light pulses of 1, 3 and 5 h duration all produced a unimodal response curve with one peak of long-day effect exactly in the middle of the night. The results of resonance experiments with *T.urticae* will be reported which may elucidate whether the circadian system is somehow involved in photoperiodic time measurement in spider mites. Theoretical implications for a model of photoperiodic time measurement will be discussed.

3S-1,13

MECHANISM OF PHOTOPERIODIC INDUCTION OF DIAPAUSE IN MANDUCA SEXTA. BELL, R.(USDA,SEA, AR, Otis Methods Development Center, Otis AFB, Ma. 02542, USA)

The occurrence of pupal diapause in Manduca Sexta is determined by the photoperiod experienced during the egg and larval feeding stages. At 25° C, daily photoperiods of less than 13.5 hours induce diapause; longer photoperiods promote continuous development. Maximum incidence and duration of diapause was induced by the longest photoperiod (13.25 hours) capable of producing 100% diapausing pupae. Short inductive photoperiods produced diapause of lower intensity. The diapause inducing effects of 12 hr photoperiods were readily reversed by only a few consecutive 15 hour photoperiods particularly when applied during larval feeding and growth; such long photoperiods were less effective in reversing diapause induction when applied during the time of molting.

Light breaks applied at various times during inductive nights produced different response curves depending on the number of successive dark cycles in which the light breaks were given.

Photoperiodic induction is prevented by high (33° C) and low temperature (18° C or less); optimal temperature for induction is 25-30° C which is also optimal for development.

It is concluded that the photoperiodic mechanism consists of photolabile (reversible) and thermolabile elements situated in the insect brain. Short days promote the development of an inhibitory agent that selectively blocks the translocation and/or release of developmental promoting brain hormone (prothoracicotropin) during the pupal stage. Conversely, long days stimulate production of a substance that activates release of the prothoracicotropic hormone. The photoperiodic mechanism that regulates Manduca diapause is discussed in relation to previous concepts on the nature of photoperiodic time measurement.

3S-1,14

COMPONENTS OF THE PHOTOPERIODIC MECHANISM IN THE BRAIN OF THE APHID, MEGOURA VICIAE

Steel, C. G. H. (Dept. Biol., York Univ., Toronto, Canada)

The photoperiodic mechanism in Megoura is maternal and controls the determination of female embryos in the ovarioles of a pregnant parent into either virginoparae or oviparae. Transfer of a parent aphid from 'long' days to 'short', or vice-versa, causes a switch from the production of one morph to the other at a predictable point during adult life. This ability to execute photoperiodic switching has been analysed in parent aphids subjected to localised lesions in the brain produced by R.F. cantery.

Destruction of Group I neurosecretory cells (NSC) in the protocerebrum abolishes photoperiodic responsiveness without impairing other functions of the brain. Massive damage to other NSC, to the compound eyes and optic lobes is without effect. It is concluded that Group I NSC are the effectors, secreting a virginopara-promoting substance which is released in long days but not short. An area of neurons slightly lateral to the Group I NSC is also part of the photoperiodic mechanism; these neurons appear to regulate secretion from Group I NSC via synapses deep in the cerebral neuropile, suggesting that they comprise the neuronal photoperiodic clock and probably also the photoreceptors.

3S-1,15

PHYSIOLOGICAL MECHANISM OF PHOTOPERIDIC INDUCTION OF PUPAL DIAPAUSE IN LEPIDOPTERA.

Tyshchenko,V.P.

The photoperiodic induction of pupal diapause in Barathra brassicae and Acronycta rumicis is founded on a special mechanism, which prevents the liberation of neurosecretory material from the brain after pupation. This mechanism is assumed to include two circadian oscillators, photoperiodic memory, inhibitory and excitatory neurons, connected with neurosecretory cells through synaptic contacts. According to recent evidence endocrine inactivity of the brain in diapausing pupae of Lepidoptera is due to inhibitory influences of the neurons on neurosecretory cells.

3S-1,16 THE RELATIONSHIP BETWEEN CIRCADIAN CLOCKS AND ECDYSIS IN INSECTS. Truman, J.W., Taghert, P.H., Tublitz, N., and Copenhaver, P.H. (Dept. Zool., Univ. Washington, Seattle, WA 98195 U.S.A.

Ecdyses in insects fall into 2 categories with respect to their association with a circadian oscillator. Gated ecdyses (such as adult eclosion in most holometabolous insects) are directly controlled by a circadian oscillator and occur at a time dictated by an interaction of this clock with the developmental program of the insect. Developmentally triggered ecdyses (most larval ecdyses) occur at a precise time in the developmental program of the insect irrespective of time of day. The latter ecdyses often appear rhythmically in a population but this is secondarily imposed by a prior gating of prothoracicotropic hormone secretion to initiate the molting process.

In Lepidoptera all of the ecdyses are triggered by the eclosion hormone but this hormone may come from either of 2 endocrine centers -- one in the brain and the other in the ventral chain of ganglia. The former center is associated with an extraretinal photoreceptor and clock and is used during gated ecdyses. The latter center controls developmentally triggered ecdyses. The association of these 2 centers in the control of embryonic and post-embryonic ecdyses in moths will be discussed as will the applicability of this model to insects other than Lepidoptera.

3S-1,17 LOCALIZATION OF "THE CLOCK" BY PHASE-SHIFTING EXPERIMENTS IN THE CRICKET TELEOGRYLLUS COMMODUS. Wiedenmann, Gottfried (Dept. Entomol. U.C. Berkeley, Berkeley 94720 U.S.A.)

The circadian stridulation rhythm in male Teleogryllus commodus was monitored under constant conditions (28 ± 1°C; LL 50 lx). Temporary exposure to low temperatures (1 - 2°C) induced phase-shifts of the rhythm. Delays up to 4.5 hrs (2-hr-pulses) and up to 7.5 hrs (6-hr-pulses) were found and no advances occurred. The results are grouped in phase-response-curves (PRC's) which represent properties of the underlying pacemaker. Singing activity of bilobectomized crickets is arhythmic; however, a rhythm is expressed when only one optic lobe is destroyed (LOHER 1972). A combination of PRC's, brain surgical and micro-cooling methods is used to test, whether essential parts of the oscillatory system controlling the circadian rhythm are located in the optic lobes.

3S-2,18 Silverstein, R.M. College of Environ. Sci. & Forestry, Syracuse, New York 13210

The theme of diversity, complexity, and specificity of behavior-modifying chemicals (semiochemicals) will be developed with particular emphasis on the importance of enantiomeric composition.

3S-2,19 SEX PHEROMONE IN BLATTARIA

Takahashi, S., Fukui, M. and Kitamura, C. (Pesticide Research Institute, Kyoto Univ., Kyoto 606, Japan)

Mating behavior of cockroaches has been extensively studied by many workers. The characteristic behavior in the sequence appears to be the wing-raising by males at the recognition of females of the same species. In general the wing-raising is elicited when a female sex pheromone is perceived by male's antennae either as a air-borne chemical or as a contact chemical. Most of the *Periplaneta* possess air-borne pheromones whereas *Blattella germanica* and *Nauphoeta cinerea* were found to possess contact chemical pheromones.

N. cinerea males recognize difference between male and female by contact chemoreception mostly through antennal contact to the antennae and body. The chemical factors responsible for sex descrimination were extracted from the body surface of each sex and their effect on the male wing-raising behavior was investigated.

A mixture of saturated hydrocarbons from the cuticular wax, major constituents of the wax of both sexes, have shown strong wing-raising activity. However, the wing-raising potency of intact males and females is different and the difference can be ascribed to the secondary components in the cuticular wax. The female body surface has a secondary substance which is potent in causing wing-raising activity whereas the male body surface has components which suppress wing-raising activity.

3S-2,20 THE ECOLOGICAL FUNCTIONS OF INSECT DEFENSIVE ALLOMONES

PASTEELS J.M. (Lab. Biol. Anim. Cell. Brussels University, 1050 Belgium).

The ecological functions of insect defensive compounds are reviewed and compared with those of secondary substances in plants.

Among the questions discussed are :
- individual and supraindividual selections in the evolution of defensive strategies;
- apparency and chemical defense;
- alletopathy or anticompetitor mechanisms;
- defensive compounds as kairomones;
- intraspecific variability and interspecific diversity of defensive blends;
- defensive compounds as pheromones.

It is stressed that the biological meaning of allomones cannot be apprehended unless they are considered in relation with the whole community in which they have evolved.

3S-2,21 FUNCTIONS OF KAIROMONES IN INSECT CONTROL.

Lewis, W. (USDA-SEA-AR, Southern Grain Insects Research Laboratory, Tifton, GA 31794)

Body odors of plant-feeding insects are a primary factor affecting their vulnerability to entomophages in that these enemies use the odors as kairomones to locate host insects for attack. A knowledge of the chemical nature of these chemicals and their role is fundamental to understanding the ethology of host and prey selection by entomophagous insects. An analysis of the function of these kairomones and strategies for employment in biological control programs will be presented.

3S-2,22

Comparative Chemical Ecology of Termites and Termitophiles
Ralph W. Howard (Forestry Sciences Laboratory, Gulfport, MS USA)

Termite colonies constitute a closed community in which semiochemicals function as the primary means of communication among the inhabitants. Semiochemicals used by Reticulitermes spp. and their staphylinid beetle cohorts include trail pheromones, caste-controlling pheromones, and caste- and species-recognition cues. The chemical and behavioral aspects of these systems will be discussed.

3S-3,23

MODES OF ACTION OF INHIBITORS OF CUTICLE FORMATION IN INSECT ORGAN CULTURES
Marks, E. P. and Terrance Leighton

Recent studies have shown that a number of unrelated chemicals are specific inhibitors of chitin biosynthesis. However, all are less effective than diflubenzuron by at least an order of magnitude. Evidence is accumulating that diflubenzuron may function as a peptidase inhibitor preventing the activation of the chitin synthetase zymogen. This, in turn, produces a biological amplification effect that can account for the very high level of activity of this compound. Since this effect is evident only in whole cell preparations, new assay systems must be developed to study these effects. The possibility of using cuticle-producing insect cell lines is under investigation.

3S-3,24

CUTICLE FORMATION AND SCLEROTIZATION IN VITRO. Riddiford, L.M., Wolfgang, W.J., & Kiguchi, K. (Dept. Zool., Univ. Wash., Seattle, Wash., U.S.A.)

Endocuticle deposition during the 5th larval instar of the tobacco hornworm, Manduca sexta, was studied both in vivo and in vitro. During the first two days of growth vertical bundles of chitin microfibrils (5μ diameter) are secreted by specialized regions of each epidermal cell. Thereafter only lamellate endocuticle is deposited. As the animal grows, the surface area of the cuticle increases. The apical lamellae are compressed and the vertical bundles of chitin microfibrils are seen to stretch more than the surrounding material. Lamellate endocuticle is deposited continually by epidermis cultured in defined Grace's medium without added hormones, but in the absence of an expanding volume the apical lamellae do not become compressed as in vivo nor do the vertical bundles stretch. The relative roles of stretching and intussusception in larval cuticular growth will be discussed.

Sclerotization of newly formed pupal cuticle in vitro depends on a factor(s) normally present in larval epidermis which is lost to the hemolymph or to the medium upon exposure to 20-hydroxyecdysone (20HE). Thus epidermis from feeding larvae cultured with 20HE for three days, then in hormone-free media, forms tanned pupal cuticle by the seventh day, whereas that from wandering stage larvae does not. When the two are co-cultured, the wandering stage epidermis can utilize this factor(s) and tans over 50% of the new cuticle by the seventh day. A pink color appears in the medium after 60 hrs of culture of larval epidermis with 20HE and again when the pupal cuticle is tanning. Therefore, its chemical identity and its relationship to sclerotization is under investigation. Supported by grants from NSF, NIH, and Rockefeller Foundation.

3S-3,25

The Control of Chitin Biosynthesis in *Plodia internunctella*

Oberlander, H. and Ferkovich, S. M. (AR-SEA, USDA, P.O. Box 14565, Gainesville, FL 32604)

The development of tissue culture techniques and the availability of ecdysteriods has made it possible to investigate the hormonal control of chitin biosynthesis in insects. We have examined chitin biosynthesis in the epidermis and imaginal discs of the Indian meal moth, (*Plodia interpunctella*) by means of injection of radioactive precursors into whole larvae and by incubation of tissues with hormone and isotope *in vitro*. In the last instar chitin is produced at its highest levels during the prepupal stage. There is also a small amount of chitin made early in the last larval instar, but the imaginal discs at this time are inactive. Both the epidermis and wing imaginal discs make chitin in tissue culture in response to 20-hydroxyecdysone. The threshold for the response of discs to hormone was 2×10^{-7} M, with a minimum exposure of 16 hours. Inhibitors of RNA and protein synthesis blocked the initiation of chitin synthesis depending upon the time of application. Our results are consistent with the hypothesis that ecdysteroids stimulate metamorphosis by promoting RNA and protein synthesis during a hormone-dependent period followed by hormone-independent protein synthesis.

3S-3,26

LARVAL AND PUPAL CUTICLE PROTEINS OF *DROSOPHILA MELANOGASTER*: PROPERTIES, GENETICS AND SYNTHESIS.

Fristrom, J., Kimbrell, D., and Silvert, D. (Dept. of Genetics, Univ. of Calif., Berkeley, CA 94720).

Cuticle proteins, soluble in detergents, urea, and guanidinium HCl, but not in water or saline solutions, have been extracted from white larval pupal cuticles of *Drosophila melanogaster*. The larval proteins are composed of 5 major and many minor components. The major proteins have apparent molecular weights in the range of 8,000 to 10,000 daltons. Electrophoretic variants affecting four of the five major larval proteins have been isolated. A variant for one protein maps to the distal portion of the left arm of chromosome 3, the rest of the variants to a proximal region on the right arm of chromosome 2. The pupal proteins are composed of nine major and many minor components. The major proteins have apparent molecular weights of 10,000-90,000 D. The pupal proteins are synthesized by imaginal discs cultured *in vitro* in association with procuticle formation in response to removal of exogenous ecdysteroid from the culture medium.

3S-3,27

CHEMICAL FINE STRUCTURE OF PUPARIAL PROTEIN.

H. Lipke, W. Henzel and M. Sugumaran. Dept. of Biolgoy, University of Massachusetts/Boston, Dorchester, MA 02125.

During pupariation in *Sarcophaga*, 26-30 related but non-identical proteins undergo (1) concerted polymerization (2) arylation of lysyls (3) peptidylation of glcNAc (4) extrusion of bound H_2O. Precursor monomers from larval cuticle are heterogeneous at N-termini, similarity in polar:non-polar and acidic:basic ratios falsely suggesting biochemical equivalence or community of function (Table I).

PROTEIN	NH_2-termini	COOH-terminus	pI	Mol. wt	Bound Dopamine	Polar:non-polar
III	H_2N-gly-his-asp	his-COOH	4.1	20,500	+	-
XI	H_2N-asp-ser-arg	his-COOH	5.0	21,400	+	1.9
XII	H_2N-tyr-tyr-	his-COOH	4.9	21,900	+	2.2

Labelled dopamine is bound to larval proteins during wandering stage and is not released from isolated proteins by exchange with unlabelled dopamine. Binding does not occur *in vitro* in the presence or absence of homologous polyphenol oxidase, however conversion to acidic metabolites accompanies conjugation with polypeptide. With onset of pupariation, additional benzenoid adducts are recovered, including Pau's aryllysines. High specificity is manifest for the arylating species and for amino acid uptake (Table II). Since general protein synthesis is limited, specific bridge peptides may be formed which include residues to be arylated.

Puparial Precursor	Relative Specific Activity		
	SDS-sol	Urea-sol	Residue
Yield	(50%)	(5%)	(25%)
NAc-Dopamine	10	5	1
Dopamine	5	5	50
Tyrosine	15	7	14
Lysine	50	7	15
Histidine	100	60	5

Support in part by NIH grant R01-AI-14753.

3S-3,28 ION TRANSPORT ACROSS THE INTEGUMENTARY EPITHELIUM OF DEVELOPING HORNWORMS, Manduca sexta.

Jungreis, A.M. (Dept. Zool., Univ. Tennessee, Knoxville 37916 USA)

Preliminary to ecdysis, cuticular hydrolysis is initiated concomitant to the secretion of moulting fluid, whereas hydrolysate re-utilization is facilitated by resorption of moulting fluid. In *M. sexta*, moulting fluid--whose composition is invariant throughout the period of moulting fluid elaboration--is a weakly alkaline (pH 7.2) solution of potassium bicarbonate (ca. 110 mM) rich in amino acids (80 mM). Bicarbonate appearing in moulting fluid probably arises within the integumentary epithelium, since this tissue possesses 70% of the total carbonic anhydrase activity present during secretion and resorption of moulting fluid. When measured under both *in vitro* and *in vivo* conditions, the exuvial = cuticular = apical side of the integumentary epithelium has a trans-membrane potential that is always 7-20 mV electropositive relative to the hemolymph side, with characteristic tissue resistances of 300-600 ohms. During secretion of moulting fluid, 70% of the short circuit current (I_{sc}) of integuments studied *in vitro* in modified Ussing type chambers can be assigned to K^+, whose transport occurs in the absence of Na^+, and regardless of bathing solution anion. During fluid resorption, K^+ is not actively transported. Although active Cl^- transport is initiated during resorption, its 15% contribution to the I_{sc} at the "non-physiological" concentration of 18 mM (vs 5 mM *in vivo*), coupled with the absence of active transport of any measured compound in the bathing medium, rule out an exogenous origin for the I_{sc} during moulting fluid resorption. By analogy with results obtained *in vitro*, neither Ca^{++} nor amino acids can contribute significantly to the *in vivo* bulk flow of resorbed fluid. Supported by NIH Grant #AI-12779.

3S-3,29 CUTICULAR LIPIDS AND THEIR ROLE IN CONTROLLING TRANSPIRATION.

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Although all layers of the cuticle as well as the epidermal cells contribute to the impermeable integument that characterizes most terrestrial arthropods, the principal barrier to water efflux for most species are lipid layers or impregnated waxes associated with the epicuticle. Recent studies have shown that certain physicochemical properties of lipids determine their effectiveness in reducing water loss. Positive correlations have been demonstrated between surface wax density and transpiration, especially when xeric-adapted species are compared with species from more mesic habitats. The quantity of specific lipid classes (e.g., hydrocarbons) are also important as are the chain length, degree of saturation, and extent of branching of component molecules within the class. For example, lipids extracted from the integument of desert insects and arachnids typically feature an abundance of long-chain, saturated hydrocarbons with branched alkanes often predominant. Furthermore, arthropods can, within genetic constraints, alter the composition of their cuticular lipids to improve impermeability when environmental conditions dictate the need for increased water conservation.

3S-3,30 BIOSYNTHESIS OF INSECT CUTICULAR WAXES.

Blomquist, G. J. (Dept. of Biochem., Univ. of Nevada, Reno Nevada, USA)

The biosynthesis of insect cuticular hydrocarbons has been shown to proceed by the elongation of C_{16} and C_{18} fatty acids followed by decarboxylation. The direct decarboxylation of hexacosanoic and tetracosanoic acid to *n*-alkanes one carbon unit shorter has been demonstrated *in vivo* in cockroaches and termites, and the *in vitro* decarboxylation of tetracosanoic acid was studied in a termite. The first step in the reductive decarboxylation of very long chain acids appears to be α-hydroxylation. The enzymatic activity was located primarily in the microsomal fraction, had a pH optimum of 6.0, was stimulated by ascorbic acid, and was not affected by the addition of ATP, CoASH and $MgCl_2$. The methyl groups of the mono- and dimethyl branched alkanes arise from the substitution of a methylmalonyl-CoA in place of malonyl-CoA during chain elongation. Carbon-13 nmr studies showed that the label from [$1-^{13}C$] propionate was incorporated exclusively into the number 4 position of 3-methylpentacosane, showing that the methylmalonyl-CoA unit was added as the second unit during chain synthesis. It appears that methylmalonyl-CoA is formed from either propionate or succinate. (Z)-9-Tricosene (muscalure), a cuticular lipid component in the housefly, is synthesized in the female by the epidermal cells of the abdomen by the elongation and decarboxylation of oleic acid. The american cockroach can synthesize linoleic acid *de novo*, which then serves as a precursor to (Z,Z)-6,9-heptacosadiene. The age of the insect has a dramatic effect on the production of wax in some species, including the housefly and honeybee. (Supported in part by USDA CRGO grant 7801064 and NSF grant PCM 76-20694).

3S-3,31 THE CHEMISTRY OF CUTICLE. Hackman, R.H. (CSIRO Division of Entomology, Canberra, A.C.T. Australia)

A critical review and discussion of two unresolved problems, the molecular basis of hardening and darkening and the conformation of cuticular proteins. Hardening and darkening are the end results of a complex of chemical and physical changes, the precise nature of which differs in different cuticles. Cuticular proteins adopt a conformation appropriate to the cuticular environment and they are part of the complex.

3S-4,32 METABOLIC ASPECTS OF FATTY ACID ABSORPTION IN SOME LEPIDOPTERA

Turunen, S. (Dept. Zool., Univ. Helsinki, 00100 Helsinki 10, Finland)

In the cabbage butterfly, *Pieris brassicae*, the rate of lipid absorption from the diet increases in the following order: triacylglycerols, free fatty acids, diacylglycerophospholipids. The possible mechanism of absorption into the hemolymph and the subsequent transport of dietary lipids are examined. Comparison of various dietary essential fatty acid sources suggests that due to incomplete digestion and absorption triacylglycerols are poor sources of essential fatty acids for some lepidopterans, and their use in diets to the exclusion of other lipids may contribute to essential fatty acid deficiency in which tissues accumulate lipids rich in monounsaturated fatty acids.

3S-4,33 FATTY ACID METABOLISM IN PARASITIC HYMENOPTERA. Thompson, S.N. (Div. Biol. Cont., Univ. Calif., Riverside, California, 92521, USA)

Triglyceride and fatty acid metabolism in parasitic Hymenoptera are markedly influenced by dietary host lipids. Specifically, the fatty acid composition of the esterified lipids of the parasites is indirectly regulated by that of their hosts. This results in the parasite displaying a near identical composition as the host and is more exaggerated than the similar situation described in other metazoan parasites. Furthermore, the composition in parasitic Hymenoptera is determined by active metabolic processes rather than the loss of synthetic ability and direct deposition of host fat which characterizes the parasitic helminths. *In vivo* and *in vitro* studies indicate that the regulation of fatty acid composition lies at the level of triglyceride synthesis rather than fatty acid synthesis and non-lipid dietary components alter this specificity as well.

3S-4,34 ESSENTIAL FATTY ACID REQUIREMENTS AND METABOLISM OF MOSQUITOS. Dadd, R.H., (Dept. Ent. Sci., Univ. California, Berkeley, 94720, USA.)

Polyunsaturated fatty acid is essential in the diet of a majority of insects studied. Either linoleic or linolenic acid satisfies the requirement in many insects, but several Lepidoptera require linolenic acid specifically to prevent the failure of pupal/adult ecdysis that is characteristic of fatty acid deficiency. Recently, mosquitos were found to require arachidonic acid for normal adult emergence and flight. For *Culex pipiens* this requirement could not be satisfied by linoleic or linolenic acids, but several polyunsaturates with a structural similarity to arachidonic acid were effective substitutes. Arachidonic acid was not effective as a substitute for linoleic or linolenic acids for those few species of insects with which it has been tested. In contrast, it is the most potent and physiologically important fatty acid for warm-blooded vertebrates, and if not present in food vertebrates metabolize arachidonic acid from linoleic acid and others of the omega 6 family. Cats, however, cannot derive arachidonic acid from linoleic acid and thus, like mosquitos, require dietary arachidonic acid or similar polyunsaturates. A speculative comparison between insect and vertebrate fatty acid requirements is offered.

3S-4,35 STEROL METABOLISM IN THE SILKWORM (*BOMBYX MORI*). Morisaki, M., Fujimoto, Y., Takasu, A., Isaka, Y. and Ikekawa, N. (Lab. Chem. Nat. Prods. Tokyo Inst. Tech., Yokohama 227, Japan)

Fucosterol 24,28-epoxide is a key intermediate of sitosterol dealkylation in phytophagous insect. Metabolic studies with the silkworm *Bombyx mori* indicated that fucosterol was converted in vivo and in vitro to a mixture of the 24S,28S and 24R,28R stereoisomers of the epoxide, which in turn were transformed into desmosterol. Isolation and identification of this epoxide from *B. mori* was accomplished by the use of various chromatographic methods including HPLC and GC-MS, and it was found to be a mixture of the 24S,28S and 24R,28R stereoisomers. By analogy to sitosterol metabolism, stigmasterol would be dealkylated through olefin/epoxide intermediate. In fact, (24E)- and (24Z)-stigmasta-5,24(28)-dien-3β-ols completely satisfied the insect sterol requirement and effeiciently converted to desmosterol and cholesterol. Several cholesterol analogs (C_{22}-C_{31} sterols) with modified side chain were fed as sole sterol component in the artificial diet. A slight structural modification from cholesterol severely retarded the insect growth and development. 25-Fluorocholesterol was found to be a good sterol nutrient and being transformed into desmosterol and cholesterol.

3S-4,36 CHANGES IN ECDYSTEROIDS DURING DEVELOPMENT AND METAMORPHOSIS OF THE BEETLE, *XYLEBORUS FERRUGINEUS*, THAT REQUIRES A DIETARY Δ^7-STEROL. Norris, D. and Rao, K. (Dept. Ent., Univ. Wisconsin, Madison, 53706 USA)

Metamorphosis of *Xyleborus ferrugineus* requires a dietary Δ^7-sterol that is naturally supplied by fungal ectosymbiotes (Chu et al., 1970). A unique spectrum of ecdysteroids was characterized, especially in pupae, using HPLC for qualitation and both RIA and HPLC for quantitation. RIA-positive compounds were found in eggs. Second-instar larvae contained about 200 pg of ecdysteroids per mg body weight; whereas, third instars had less than 100 pg. In 36-hour-old pupae ecdysteroid titer peaked at about 750 pg/mg. Both α and β-ecdysones were present in pupae; the latter was in relatively higher concentrations during late pupal life. Two other compounds, eluting between α- and β-ecdysone, constitute major constituents in the pupa, and probably help explain the insect's requirement of dietary Δ^7-sterol.

3S-4,37 Sterol biosynthesis by symbiotes of leafhoppers

Noda, H. (Shimane Agr. Expt. Stn., Izumo, Shimane 693, Japan)

Sterol ingestion is generally indispensable for insects because of their incapability of sterol biosynthesis. Some insects, however, grow normally without sterol supply. The smaller brown planthopper, Laodelphax striatellus, for instance, can complete the whole life cycle without sterols. This planthopper harbours the intracellular yeastlike symbiotes which are transmitted through female ovary from generation to generation. The heat of 35°C destroyed the symbiotes, that led to the abnormal insect growth. The deleterious effect of the heat was partly recovered by the sterol supply. L. striatellus possessed three sterols, cholesterol, β-sitosterol and 24-methylenecholesterol. β-Sitosterol appears to derive from the host plant, the rice plant. The heat-treated insects in which the symbiotes were destroyed showed markedly reduced amount of 24-methylenecholesterol, suggesting that this sterol is synthesized by the symbiotes. The yeastlike symbiotes in L. striatellus take a great part in the host insect nutrition as sterol suppliers.

3S-4,38 Comparative Sterol Metabolism in Insects. Svoboda, J., Thompson, M., and Robbins, W.

Most insects have a critical need for dietary sterol and the utilization and metabolism of these sterols varies considerably among species. The tobacco hornworm, Manduca sexta (L.) and several other lepidopteran species readily convert C_{28} and C_{29} plant sterols to cholesterol through dealkylation utilizing a common intermediate, desmosterol, to satisfy their needs for cholesterol. Omnivorous species such as cockroaches do not make these conversions as readily, but do produce significant quantities of cholesterol from phytosterols via the same metabolic pathways. By comparison, the plant feeding Mexican bean beetle, Epilachna varivestis (Mulsant), produces mainly saturated sterols, lathosterol and very little cholesterol from C_{29} plant sterols, whereas, the sterols of the predacious coccinellid, Coccinella septempunctata (L.), reflect the sterol content of its prey. A stored product insect, Tribolium confusum Jacquelin duVal, exemplifies further diversification of sterol metabolism since it is capable of converting dietary C_{28} and C_{29} plant sterols to nearly equivalent levels of cholesterol and 7-dehydrocholesterol. However, another stored product insect, Trogoderma granarium Everts is unable to dealkylate dietary plant sterols, but is capable of selective uptake of cholesterol and campesterol from the diet. The milkweed bug, Oncopeltus fasciatus (Dallas) is a phytophagous insect that is unable to convert plant sterols to cholesterol, but utilizes the unchanged dietary sterols to fulfill its sterol requirements. The honey bee, Apis mellifera L., lacks the capacity to convert a measurable amount of C_{28} or C_{29} plant sterols to cholesterol and the common pollen sterol 24-methylenecholesterol is the major sterol in all stages of this insect regardless of the sterol included in artificial diets. Adaptations to the numerous ecological niches and food sources utilized by insects apparently have been accompanied by corresponding physiological and biochemical adaptations in sterol utilization and metabolism.

3S-4,39 LIPID FACTORS IN GROWTH AND REPRODUCTION. McFarlane, J. (Dept. Ent., McGill Univ., Quebec, Canada)

Vitamin E is essential for spermatogenesis in the house cricket, Acheta domesticus (L.), an effect which is dependent on the ring structure of α-tocopherol. A relationship between vitamin E and copper metabolism in the testis has been established. The Vitamin E antagonist tri-o-cresyl phosphate sterilizes house crickets fed vitamin E by decreasing sperm motility; spermatogenesis is unaffected. Vitamins E and K_1 individually improve growth of the house cricket. As sub-threshold amounts of these vitamins have an additive effect, growth improvement seems to depend on the similar side chains of these compounds.

3S-5,40 STRUCTURE AND FUNCTION OF ANTENNAL HYGRORECEPTORS OF THE COCKROACH PERIPLANETA.

Yokohari F.* and Tominaga Y.** (Dept.Biol.,Kyushu Univ.,Fukuoka,812 Japan*, Biol.Lab.,Fukuoka Univ.,Fukuoka,814 Japan**)

Antennal hygroreceptors of the cockroach, Periplaneta americana have been examined both electrophysiologically and electron microscopically. The moist and dry hygroreceptors, together with a thermal receptor and a functionally unidentified cell, are contained in a sensillum capitulum. The responses of both hygroreceptors, when the whole animal and stimulus air are changed simultaneously, are larger at higher than at lower temperatures, but the normarized humidity-response relationships at different temperatures are coincident when plotted against relative humidity but not when against absolute humidity. The humidity-response relationships at different temperatures, if only the stimulus temperature is changed, are coincident when plotted against relative humidity as well. The moist receptor responds to liquid water with pattern almost identical to that by 100% r.h. air, and is inhibited by glycerin. The dry receptor is inhibited by liqiud water and excited by glycerin. Futhermore, both the moist and dry receptors respond to mechanical deformation of the sensillum, but antagonistically. On the other hand, the sensillum capitulum is mushroom-shaped with an inner stem terminating with a cap and surrounded by an outside wall. Neither the inner stem nor the outsides wall are perforated. Two of the four sensory cilia in the sensillum are differentiated distally into tubular body-like structures. The innermost enveloping cell has structures resembling scolopale rods. The internal structure of the sensillum resembles in many ways that of the amphinematic scolopidium.

3S-5,41 GENETIC DISSECTION OF THE PHOTOTRANSDUCTION PROCESS.

Pak, W.L. (Dept. Biol. Sci., Purdue Univ., W. Lafayette, Ind., 47907 USA)

In order to dissect the phototransduction process genetically, we have isolated to date over 80 independently arising mutations affecting this process. These mutations fall into 11 complementation groups. Mutations affecting some of these loci have been described in detail previously. Many of the mutations isolated recently have their most obvious effects on the sensitivity and adaptation mechanisms of the photoreceptor. One of these mutations, ninaA, drastically reduce the amount of rhodopsin in R1-6 photoreceptors, but not in R7 or R8. We have tested the possibility that the ninaA gene is a structural gene for R1-6 opsin. Implications of our results are discussed.

3S-5,42 RECOVERY OF RESPONSE AFTER DETERGENT-TREATMENTS IN THE LABELLAR SUGAR RECEPTOR OF THE BLOWFLY.

Morita, H., Ninomiya, M., Hara, M. and Kashihara, Y. (Dept. Biol., Kyushu Univ. 33, Fukuoka 812, Japan)

The labellar sugar receptor of the blowfly, Phormia regina, discharges injury impulses when treated with 0.3% Na-deoxycholate (DOC) for 2 min, and completely loses responsiveness to sugars for a while. Then, the sugar receptor gradually recovers and attaines to almost the same level as before the treatment in about 1 h. The sugar receptor, however, recovers only poorly (less than 50% of the response before the treatment) when pretreated with 1% colchicine. Improvement of recovery of response in this colchicine-DOC double-treated sugar receptor was examined by incubating the tip of the labellar chemosensory hair with some fractions extracted from the homogenate of labella or mixtures of certain substances.

3S-5,43

Information processing in the auditory system of locusts

Kalmring, K. (Dept. Zool., Marburg Univ., West-Germany)

Complx excitatory and/or inhibitory interactions of the signals from both tympanal organs form the discharge patterns of the auditory ventral-cord neurons. Normally the input of the ipsilateral sense organ dominates.

The responses of central neurons, as a rule, are move complex than those of receptor cells. Coding of the different parameters in the sound signals is improved. At this level of the auditory pathway, for the first time, various neurons exhibit habituation.

The impulses in the auditory ventral-cord neurons pass unchanged along the main axon trunk. Neither temporal pattern nor magnitude of the response is altered. But at the many branch points of the axon the responses, may undergo spatially and temporally variable modifications, which are conducted along the side branches.

These modifications depend not only on the geometry of the parts of the axon involved, but also on the "previous history" of impulse transmission.

A model of the probable information processing in the auditory system of locusts will be given.

3S-5,44

RECENT ADVANCES ON COMPOUND EYES

Horridge, G.A. (Dept. of Neurobiology, ANU, Canberra, Australia)

Recent findings in Neurobiology Dept. ANU, Canberra include :-

1) In compound eyes with foveas there are several ways in which the diffraction limit of the lens is matched to the capture cross-section of the receptor unit. In one class of examples Rhabdom diameter is less where facet diameter is greater.

2) In some arthropods there are major changes in the rhabdom structure and size on a day-night rhythm. The locust is a notable example and has adaptations for night vision.

3) Long-term recordings from single photoreceptor cells show that there are physiological changes associated with day and night that are independent of immediate dark/light adaptation.

3S-6,45

REGULATION OF CUTICULAR PROTEIN SYNTHESIS BY HORMONES, POSITION, AND AGE.

Willis, J.H. (Dept. of Genetics and Development, University of Illinois, Urbana, IL 61801 U.S.A.)

The cuticular proteins of the giant silkmoth, *Hyalophora cecropia* have been characterized by isoelectric focusing on slab gels. Different banding patterns are found at different metamorphic stages and in different anatomical regions of a single stage. An assortment of very acidic proteins characterizes the flexible cuticles of all stages.

Cuticular protein synthesis continues *in vitro* when integument engaged in cuticle formation is placed in Grace's tissue culture medium. The newly synthesized proteins can be identified by autoradiography of the bands on slab gels. Study of protein synthesis in such preparations reveals that all of the cuticular proteins may be synthesized by the epidermis. There are different patterns of cuticular protein synthesis in young and old final instar larvae, and distinct differences in incorporation patterns of leucine and methionine. Methionine is not found in most of the major cuticular proteins.

Wing epidermis from diapausing pupae maintained *in vitro* can be directed to form either pupal or adult cuticle with appropriate hormonal treatment. Morphological evidence of a new cuticle is first apparent about eight days after ecdysterone administration, and synthesis of a new group of proteins begins at the same time. Cuticular protein synthesis under these conditions will also be described.

3S-6,46 HORMONAL CONTROL OF SYNTHESIS AND UPTAKE OF STORAGE PROTEINS BY FAT BODY IN THE SILKWORM, BOMBYX MORI. Tojo, S. (Fac. Agricul., Saga Univ., Saga, 840, Japan)

In the female silkworm, fat body of the mid-5th instar larva synthesizes two storage proteins (SP) and secretes SP into haemolymph and then, after spinning, selectively takes up SP (Tojo et al.,1980). Following experiments were carried with co-workers, Drs. Kimura, S. and Kiguchi, K. (Sericul. Exp. Stn., Japan). Allatectomy (-CA) one day after 3rd larval molt caused SP accumulation in haemolymph in the penultimate larval instar, and also, after precocious spinning, SP uptake by fat body. But, injection of ZR 515 over 1 ng shortly after -CA suppressed both phenomena. In vitro study now in progress suggests that SP synthesis by fat body is enhanced by β-ecdysone. Allatectomy 2 days before final larval molt did not hastened the time of beginning of SP synthesis in the final larval instar, but caused SP uptake 2 days earlier than in sham-operated control. In the abdomen of 5th instar larva ligatured between thorax and abdomen in the late-feeding stage, SP uptake by fat body was blocked, but injection of β-ecdysone into it was effective for induction of this event. These results suggest that SP synthesis by fat body is induced by first release of ecdysone under threshold level of juvenile hormone (JH) and SP uptake by it is also triggered by ecdysone, again timed by decrease of JH under threshold level during larval-pupal transformation.

3S-6,47 VITELLOGENIN SYNTHESIS AND ITS CONTROL BY JUVENILE HORMONE IN LOCUSTA. Wyatt, G.R. (Dept. Biol., Queen's Univ., Kingston, Ont. K7L 3N6, Canada)

Vitellogenins (VG), yolk precursor proteins, are produced in insect fat body usually under juvenile hormone (JH) control, in some species under control by ecdysone or other factors. In Locusta migratoria, VG, a glycolipoprotein of MW 550,000, is assembled from two precursors with MW 230,000 and 215,000. In female adults, synthesis normally begins about day 8 and rises to a peak for the first gonotrophic cycle about day 13. Synthesis is prevented by surgical or chemical removal of the corpora allata and restored by treatment with JH or a JH analog, ZR-515 (JHA). Synthesis has been studied in female fat body in vitro after induction in vivo, but can also be induced by JHA added directly to fat body cultured in vitro. The hormone induces DNA synthesis, resulting in increased polyploidy. Fat body RNA has been analyzed and VG mRNA identified as a distinct, 7000-nucleotide, female-specific band in denaturing gel electrophoresis. After initial exposure of female fat body to JHA, VG mRNA is synthesized after a lag of about 48 hours and there is also rapid synthesis of ribosomal RNA; in a secondary response to JHA (after decline of the primary response), VG mRNA synthesis is much more rapid and rRNA synthesis much less stimulated. Male fat body responds to JHA by DNA synthesis but does not make VG. In fat body of both sexes, a cytoplasmic JH receptor, distinct from the hemolymph JH-binding protein, has been identified. It is concluded that JH acts on adult fat body at the nuclear level, stimulating transcription, and that in the female, but not in the male, the VG genes are specifically programmed to respond. cDNA, prepared by reverse transcription of female fat body RNA, has been inserted into a plasmid vector and cloned, clones carrying VG sequences have been selected, and study of the hormonal induction process is continuing with the use of these as hybridization probes. (Supported by Canada NSERC and US NIH.)

3S-6,48 HORMONAL CONTROL OF VITELLOGENIN SYNTHESIS IN A MOSQUITO. Hagedorn, H.H. (Dept. Ent., Cornell Univ., Ithaca, NY)

Vitellogenin and vitellin in the mosquito Aedes aegypti are indistinguishable. Both have a native size near 260,000 Daltons. On SDS gels 5 major subunits are present, 2 near 200,000 and 3 near 60,000 Daltons. Pulse-chase experiments fail to demonstrate a larger precursor. The synthesis of vitellogenin is controlled by ovarian ecdysone. The production of ecdysone is regulated by the neurosecretory hormone EDNH released after a blood meal. EDNH is a peptide with a size near 6,500 Daltons. Patterns of DNA, RNA and protein synthesis in the fat body demonstrate the massive response of this tissue to ecdysone. Inhibition of vitellogenin synthesis by α-amanitin and cordecepin in vitro suggest that ecdysone acts at the transcriptional level. Juvenile hormone is also involved in the control of vitellogenin synthesis. It has both behavioral and physiological effects on the female. It causes previtellogenic growth of the ovary and the development of competence to respond to EDNH. It also causes the fat body to develop competence to respond to ecdysone. One of the most interesting problems we face is determining what happens in the fat body and ovary during the development of competence, and the related question of determining the mechanism of action of EDNH, juvenile hormone and ecdysone.

3S-6,49 THE CONTROL OF YOLK PROTEIN SYNTHESIS IN *DROSOPHILA MELANOGASTER*. Bownes, M. (Dept. Molec. Biol., Edinburgh Univ. Edinburgh, UK)

The yolk proteins of *Drosophila melanogaster* are synthesised in both the ovary and fat body of the adult female and stored in the developing oocyte to provide a nutrient source during embryogenesis. Experiments identifying various factors which control the synthesis, secretion and uptake of the yolk proteins will be described. These will include the effects of juvenile hormone and ecdysone on vitellogenesis; and the use of mutants affecting either sex determination or vitellogenesis in analysing the control of synthesis of the yolk proteins in *Drosophila*.

3S-6,50 *IN VITRO* TRANSCRIPTION OF CLONED tRNA GENES OF *BOMBYX MORI*. Garber, R., and Gage, L.P.* (Dept. Cell Biology, Roche Institute of Molecular Biology, Nutley, New Jersey 07110 USA)

The tRNAs for alanine and glycine increase dramatically in abundance in the silk gland of *Bombyx mori* when silk fibroin, a protein rich in these two amino acids, is made. Adaptation of the tRNA population to the composition of a cell's major protein product is common in highly differentiated tissues and may reflect the action of a transcriptional regulatory mechanism coordinating the expression of protein and tRNA specifying genes. We have approached this question by analysis of the transcription of cloned tRNA genes *in vitro*. Two different cloned genes for $tRNA_2^{Ala}$ are transcribed and processed efficiently in nuclear extracts prepared from frog oocytes. Two composite genes constructed to contain a complete $tRNA_2^{Ala}$ coding sequence with the 5' flanking DNA of one "parental" clone and the 3' DNA of the other were also transcribed and their precursor tRNA products processed into mature $tRNA_2^{Ala}$. One gene functioned with as few as 9 bp of *B. mori* DNA sequence 5' of the gene and a third composite gene which was deleted for DNA encoding the 3' terminal third of the tRNA, also was actively transcribed. Hence, information sufficient for RNA polymerase III transcription in the frog oocyte extract is contained within the 5' terminal two-thirds of the gene and 9 bp preceding it. The $tRNA_2^{Ala}$ clones were also tested in a whole cell transcription extract prepared from *B. mori* posterior silk glands. This extract was extremely selective, transcribing only one of the two "parental" tRNA clones and two of the three composite clones. Comparison of the sequence composition of these genes readily revealed that the capacity for transcription correlated uniquely with the presence of a particular 5' flanking DNA sequence. The gene recognition elements required by the frog oocyte extract are probably also required for transcription in the silk gland extract. An additional requirement for particular 5' flanking DNA sequences could form the basis for differential expression of tRNA genes in the silk gland.

3S-7,51 HORMONAL AND BIOCHEMICAL CONTROL OF EGG DIAPAUSE IN SILKWORMS. Yamashita, O., Yaginuma, T. and Hasegawa, K. (Fac. Agric., Nagoya Univ., Nagoya, 464 Japan)

Egg diapause of silkworms is under a specific hormonal control, in which a neurohormone, diapause hormone is required for diapause induction. The diapause processes are accompanied by biochemical events making specific physiological adjustment. The carbohydrate metabolism is typical in such a biochemical system; much accumulation of glycogen in oocytes at the induction, rapid conversion of glycogen to sorbitol in eggs at the initiation and resynthesis of glycogen from sorbitol at the termination. we have established the metabolic pathway and the rate-limiting enzymes in these processes; trehalase, glycogen phosphorylase and NAD-sorbitol dehydrogenase. Trehalase activity is shown to be under the control of the diapause hormone.

3S-7,52 HORMONAL CONTROL OF DIAPAUSE AND PHASE VARIATION IN SOME LEPIDOPTEROUS LARVAE.

Yagi, S. (Lab. Appl. Ent., Tokyo Univ. of Agric. and Technol., Fuchu, Tokyo 183, Japan & ICIPE Research Centre, P. O. Box 30772, Nairobi, Kenya)

The present paper deals with several aspects of the role of juvenile hormone(JH) in diapause and phase variation in some lepidopterous larvae. In the species studied, it was concluded that the secretory activity of the corpora allata is greatly affected by environmental conditions, such as photoperiod, temperature, moisture levels and population density during rearing. As the results of activation of corpora allata by environmental conditions, larval period, especially the last larval stage, was prolonged and spermiogenesis was inhibited.

It is suggested that JH, which has been known to regulate larval diapause of the rice stem borer, *Chilo suppressalis*, plays an important role in the physiological changes of various lepidopterous larvae including not only larval diapause but also phase variation. On the other hand, it is highly possible that (a) proteinic hormone(s) secreted from neuroendocrine organs such as brain, corpus cardiacum-corpus allatum complexes and suboesophageal ganglion has(have) an important role in regulation of phase variation such as larval colouration in some lepidopterous species.

3S-7,53 LARVAL DIAPAUSE OF THE SOUTHWESTERN CORN BORER: HORMONAL AND METABOLIC ASPECTS.

Chippendale, G. M. (Dept. Ent., Univ. Missouri, Columbia, MO 65211, USA)

Some neuroendocrine and metabolic events associated with the facultative larval diapause of the southwestern corn borer, *Diatraea grandiosella*, will be described. When larvae of this corn borer are reared under short days and low temperatures they enter diapause at the end of their final instar, retain active corpora allata, and contain a substantial titer of juvenile hormone in their hemolymph. The diapause response will be discussed with reference to a possible interaction between the brain and the corpora allata, the effect of JH on protein synthesis in the fat body, and the stability of JH in the hemolymph. Evidence will be presented that the fat body of pre-diapausing larvae, under the control of JH, accumulates selected proteins that may function during diapause. Information will be presented about a low molecular protein and a high molecular weight protein that fit into this category. These proteins were found to be released from the fat body of newly diapaused larvae *in vitro*, and may function in the hemolymph during diapause. Some properties of these proteins will be described, along with their possible functions. Current information about the presence and titer of JH-binding proteins and JH-esterases in the larval hemolymph will also be discussed. Information will be included about an *in vitro* study using radiolabeled C_{18}-JH that revealed the presence in the hemolymph of last instar pre-diapausing larvae of a high affinity JH-binding protein with an apparent molecular weight of about 2.7×10^4 and dissociation constant of about 3.1×10^{-7}M at 4°C. JH also bound to at least one protein fraction of high molecular weight. A comparison of JH-esterase activity in the hemolymph of diapausing and non-diapausing larvae will also be presented.

3S-7,54 HORMONAL AND METABOLIC CONTROL OF DIAPAUSE IN LEPIDOPTEROUS PUPAE.

Berry, S.J. (Biology Dept., Wesleyan Univ., Middletown, CT 06457)

The causal element in the diapause of lepidoptera is the failure of the brain to release prothoracotropic hormone. The onset of facultative diapause and the termination of both facultative and obligatory diapause depends upon photoperiodic information. The photoreceptor has not been identified, but seems to reside in the brain rather than peripheral sensory modalities. Control of the release of prothoracotropic hormone by neurosecretory cells of the brain appears to depend on changes in the cyclic AMP content of the neurosecretory cells. A rise in the level of cAMP in the brain is the earliest biochemical event identified in the termination of diapause. Injection of cAMP at physiological levels is a necessary and sufficient stimulus for the termination of diapause in pupae which are unable to respond to photoperiodic cues. Photoperiodic regimes which suppress initiation of adult development also suppress the increase in cAMP content. When crude adenylate cyclase preparations from brains are examined, the only putative agonist which is a viable candidate for a cyclase activator is five hydrotryptamine (serotonin). Evidence will be presented to support the theory that 5HT or a very similar molecule is present in the brain. Evidence will also be presented to suggest that the interaction between the 5HT receptor and the cyclase can influence the temperature sensitivity of cyclase activity. The possible role of these observations in integrating neurosecretory activity with environmental cues appropriate for the temperate zone will be discussed.

3S-7,55 PUPAL DIAPAUSE IN DIPTERA: METABOLIC CYCLES AND HORMONAL REGULATION.

Denlinger, D. L. (Dept. Ent., Ohio State Univ., Columbus, Ohio 43210, USA)

Diapause in flesh flies poses several interesting contrasts to the classic scheme of pupal diapause derived from experiments with Saturniidae. Oxygen consumption rate, rather than being constant throughout diapause, shows distinct infradian cycles. having a periodicity of several days. The brain-prothoracic gland axis is shutdown during diapause in both taxa, but in addition, 24 hr pulses of juvenile hormone activity have been detected at the onset of diapause in flies. JH activity persists during diapause, and a pulse of JH precedes the rise in ecdysone that initiates adult development. Cyclic nucleotide levels exert a regulatory effect on both diapause induction and termination. Cyclic AMP levels in both the brain and ring gland are much lower in flies destined for pupal diapause than in flies programmed for continuous development, and diapause can be averted by boosting the level of cyclic AMP. At termination of diapause, brain and ring gland levels of cyclic nucleotides change only slightly. By contrast, whole body levels of cyclic GMP rise dramatically, and injection of cyclic GMP or combinations of cyclic GMP and suboptimal doses of 20-hydroxy-ecdysone promptly terminate diapause.

3S-7,56 HORMONAL AND METABOLIC REGULATION OF ADULT DIAPAUSE IN THE COLORADO POTATO BEETLE.

C.A.D. de Kort, Lab. of Ent., Agricult. Univ., Wageningen, The Netherlands.

The photoperiodic induction of diapause in the Colorado beetle, *Leptinotarsa decemlineata Say*, is mediated by hormones. High titres of juvenile hormone (JH) occur in long-day (LD) beetles, while low concentrations of JH are circulating under short-day (SD) conditions. The corpora allata play a central role in regulation of the JH-titre, although changes in JH-specific esterases have been shown as well.

Drastic physiological differences occur between LD and SD beetles. As flight and reproduction are the most important functions of adult insects, we studied changes in flight muscles, fat body, ovaries and haemolymph. Changes in development and degeneration of flight muscles have been described some years ago. This paper will present changes in the protein synthetic activity of the fat body related to reproduction, as well as changes in the capacity of substrate mobilization which correlate with changes in the flight muscles.

3S-8,57 PHYSIOLOGICAL INFLUENCES ON THE STORAGE, MOBILIZATION AND UTILIZATION OF ENERGY RESERVES.

Downer, R.G.H. (Dept. of Biology, University of Waterloo, Waterloo, Ont. Canada, N21 3G1)

The basic equation of energy (or caloric) balance assumes that, during the life of an animal, the total energy taken in equals the amount of energy that is expended. However, over short periods the equation of energy exchange may be markedly unbalanced. Shifts in one (or both) component(s) of the energy equation of insects may be related to specific events in the animal's life history including growth, metamorphosis, reproduction, exercise, migration, diapause, excitation and feeding. The implications of these events on the regulation of fuel metabolism are discussed in light of current theories of metabolic regulation.

3S-8,58 THE ROLE OF CARBOHYDRATE METABOLISM IN PHYSIOLOGICAL FUNCTION. Steele, J.E. (Dept. Zool., Univ. West. Ont., London, Canada).

The fat body is of central importance in the intermediary metabolism of carbohydrate. Trehalose, synthesized from glycogen in the fat body, is not only a source of oxidizable substrate but is a principal source of glycosyl residues for the synthesis of chitin. Glucose originating in the diet may be channeled into trehalose or glycogen or oxidized by the fat body. When cuticle is resorbed the glycosyl residues are temporarily returned to the fat body as glycogen to await the next period of chitin synthesis. The flux of glycosyl residues between chitin, trehalose and glycogen is controlled at numerous points.

The enzyme profile in insect flight muscle resembles that in other animals. Functionally it differs in being entirely aerobic and also the degree to which glycolytic flux can be increased (100 x). Recent studies on muscle phosphorylase have shown it to be an important control point in glycolytic flux.

Other tissues with large energy requirements have special need for carbohydrate as a source of energy. Na^+ moves into nerve cord against a gradient. This depends on oxidative metabolism in which glycogen plays a major role. Similarly, hormonal stimulation of water transport across the rectal wall depends on the creation of energy-dependent ionic gradients. The increase in glycogenolysis and O_2 consumption under these circumstances confirms the importance of carbohydrate. In certain insects the production of "antifreeze", usually glycerol, is essential for survival at low temperature. The glycerol is derived from glycogen. The mechanism responsible for preferentially converting glycogen into glycerol is not completely understood but recent studies indicate an important step is the activation of phosphorylase by low temperature.

3S-8,59 LIPID TRANSPORT IN HEMOLYMPH. Chino, H. (Inst. Low Temp. Science, Hokkaido University, Sapporo, Japan)

Since our first report on lipid transport in insects in 1964, it has been confirmed and established by many investigators that diacylglycerol (DG) is a major form by which insects transport the lipids as fuel from the storage site of fat body to the sites of utilization. Diacylglycerol-carrier-lipoprotein (DGLP), as primary vehicle for DG, has been purified from hemolymph and characterized in some lepidoptera and locusts. Most of such works have been dealing with lipid transport from fat body. Recently,however, we have purified another DGLP from hemolymph of the american cockroach in an extremely pure form, and demonstrated *in vitro* that this DGLP can serve to transport the same lipid (DG) from two different sites, the storage site of fat body and the absorption site of midgut. Such an unique function of serum lipoproteins has never been reported in other systems including mammalian system. The cockroach DGLP has higher affinity for the midgut than for the fat body, in terms of the capacity to accept DG from the tissues. Thus, it is assumed that the cockroach DGLP serves to transport DG mainly from midgut as far as the animals feed on fat-rich food, while the DGLP efficiently takes up DG from the fat body when the insects are starved or fed on carbohydrate-rich food. This seems to act as a regulatory mechanism for lipid transport and metabolism in some polyphagous insects, depending on their nutritional and physiological conditions.

3S-8,60 HORMONAL REGULATION OF FUEL TRANSPORT AND METABOLISM. Candy, D.J. (Dept. Biochem., Birmingham Univ., Birmingham, U.K.)

Hormonal influences on fuel transport and metabolism in insects will be reviewed, with emphasis on the more rapid-acting peptide hormones and the biogenic amines. The two best established hormonal influences are those of the hyperglycaemic (HG) and adipokinetic (AK) peptide hormones secreted from the corpora cardiaca. HG acts during flight of blowflies (and perhaps other carbohydrate users) to stimulate conversion of fat body glycogen to haemolymph trehalose. In locusts (lipid users) AK stimulates conversion of fat body triacyl glycerol stores to diacyl glycerol, which is secreted into the haemolymph as a lipoprotein. Both hormones appear to act by elevating cyclic AMP levels in fat body. During flight of locusts the concentration of octopamine in haemolymph is elevated to 5 times resting levels. The effects of octopamine on stimulation of oxidation in flight muscle and on release of fuels from fat body will be discussed. Other, longer-acting hormones influence the build up of reserves prior to migratory flight, egg-laying and other conditions of physiological stress.

3S-8,61 UTILIZATION OF LIPID BY THORACIC MUSCULATURE. Beenakkers, A.M.Th. (Lab. Chem. Animal Physiol., Univ. Utrecht, 3508 TB Utrecht, The Netherlands)

Lipids constitute an important storage form of metabolic energy for various energy-requiring processes, *e.g.* flight, during the life cycle of insects. The endurance of sustained flight depends on the nature and the amount of stored substrate. As fat, in contrast to glycogen, is stored without additional water, for the same flight period, and assuming an equal metabolic rate, insects metabolizing fat need less fuel loading than carbohydrate oriented insects. So, insects making migratory flights and species that do not feed as adults, can be expected to oxidize fatty acids in flight muscles.

In most lipid utilizing insects fat body triacylglycerols are converted to diacylglycerols, which are released into the hemolymph and taken up by lipoproteins under the influence of the adipokinetic hormone. Lipase activity in the flight muscles of at least some insects shows specificity to diacylglycerol. Transport of fatty acids through the mitochondrial membranes is mediated by carnitine. A survey of enzyme activities in flight muscles of various insect species demonstrates that fatty acid oxidation can occur in the above mentioned groups. Respiratory measurements with isolated flight muscle mitochondria confirm these observations. Regulation of lipid oxidation, particularly in insects capable of utilizing other substrates also, is still not fully understood.

3R-1,1 Endocrine Control of Cuticular Melanization in Fifth Instar Larvae of the Oleander Hawk Moth, Deilephila nerii. Jang, E.B. and Chang, F. (Dept. Ent., Univ. of Hawaii, Honolulu, Hawaii 96822

Approximately 72-96 hr. prior to larval-pupal ecdysis, late fifth instar larvae of the oleander hawk moth characteristically undergo a color change from green to black on the dorsum of all abdominal segments. This melanization process seems to be controlled by a blood-borne factor. Selective ligations have pinpointed the prothorax as the area involved and ecdysone as the factor responsible. Sequential injections and slow infusions of B-ecdysone (ecdysterone) at a critical time are successful in inducing melanization in non-melanized isolated abdomens. The head does not appear to be directly involved but may play a role in the timing of hormone release. Determination of ecdysone titers in the hemolymph throughout the instar indicates the presence of two releases of ecdysone; the first release coinciding closely with the first signs of melanization and the second initiating the commitment towards larval-pupal ecdysis.

3R-1,2 THE HORMONE INDUCING CUTICULAR MELANIZATION IN ARMYWORM LARVAE, LEUCANIA SEPARATA, UNDER CROWDED CONDITION. Matsumoto, S., Isogai, A., Suzuki, A., and Ogura, N. (Dept. Agric. Chem., The University of Tokyo, Tokyo, 113 Japan)

Some armyworm species show various degrees of coloration at larval stage depending on their population densities. Under crowded condition, the larvae of Leucania separata show marked black coloration, in which participates the neurohormone temporarily termed melanization and reddish coloration hormone (MRCH). MRCH was extracted with 80% ethanol from Br and SG of L. separata larvae. Furthermore, the 80% ethanol extract of whole heads of silkworm moths, Bombyx mori, showed MRCH activity. An approximately 16,300-fold purification of the extract afforded two active fractions, inducing the cuticular melanization in an L. separata larva at a dose of 0.27µg. MRCH contained in each fractions is peptidal (molecular weight, 6400-8000). Partially purified MRCH is responsible for black coloration in the cuticle of other armyworm species, Leucania loreyi, Spodoptera litura, and Mamestra brassicae.

3R-1,3

CHEMICAL PROPERTIES OF EPIDERMAL BROWN PIGMENT INDUCED BY JUVENILE HORMONE IN THE SILKWORM, BOMBYX MORI. M. Ogawa, M. Tsusué (Biological Laboratory, Kitasato University, Sagamihara, Kanagawa 228, Japan) and K. Kiguchi (Sericultural Experiment Station, Yatabe, Ibaraki 305, Japan)

Larval coloration of the silkworm, Bombyx mori, is under hormornal control. Juvenile hormone(JH) injection induces the color change of larval epidermis from grayish white to yellowish brown. The brown pigment was isolated from the JH injected larvae and its chemical properties were studied. The reduction with sodium hydrosulfite gave the pigment red color, while the oxidation with hydrogen peroxide yellow. The Rf values on the thin layer chromatography in various solvents were similar to those of xanthommatin. UV absorption spectra of the substance coincided with those of xanthommatin. These data indicate that the brown pigment is identical with xanthommatin.

3R-1,4

STRUCTURE AND DEPOSITION OF THE CUTICLE IN THE MEAL WORM (TENEBRIO MOLITOR) AS SEEN WITH THE FREEZE-FRACTURE TECHNIQUE . Noirot,Ch. and Noirot-Timothée,C. (Lab. Zoology - Univ. Dijon, 21100 Dijon, France).

The observations were made during the pupal-adult development, from the post-ecdysial secretion of the pupal cuticle to the completion of the adult cuticle, with additional observations on the tracheae. The freeze fracture technique appeared well suited for the following points : evolution of the apical plasma membrane of the epidermal cells (shape and pattern of the microvilli, and associated intramembranous particles), microfibril assemblage during the secretion of the procuticle, formation of the pore-canals. A special attention was given to the superficial layers (the so-called wax- and cement-layers) which are not preserved in sections prepared with conventional techniques for transmission electron microscopy, and appeared on freeze fracture replicas much thicker and complicated than usually stated.Especially noticeable was the evidence of several clivage planes in the deepest part (oriented wax layers ?), and another clivage plane most probably inside the outer epicuticle. On the contrary, the epicuticular filaments (= wax-canal filaments) were not recognized on replicas ; this observation does not support the lipid-water crystal constitution hypothesized for these filaments.

3R-2,5

STRETCH RECEPTORS IN THE BURSA COPULATRIX OF THE BUTTERFLY, PIERIS RAPAE CRUCIVORA, AND ITS ROLE IN BEHAVIOR. Sugawara,T.(Dept.Biol.,Saitama Med.Sch.,Saitama,350-04 Japan)

The female cabbage white butterfly, Pieris rapae crucivora, refuses to copulate after the initial mating, assuming a 'mate-refusal posture'. It has been presumed that the inflation of the bursa copulatrix, normally with a spermatophore, induces the mate refusal and that the information is conveyed through the nervous system. A pair of stretch receptors were found in the bursa copulatrix, and their morphological and physiological properties were investigated with reference to the behavioral response.

The stretch receptor is composed of a single multipolar neuron. Its soma lies on a region where muscle fibers attach to epithelial cells, extending several long processes to both the muscle layer and the epithelium. The frequency of afferent impulses from the stretch receptor was 1-3/s in virgin and 7-15/s in copulated females in which the bursa copulatrix was inflated with a spermatophore of about 6 μl in volume. Silicone oil was injected into the bursa for experimental analysis. Two response patterns were observed: phasic during injection and tonic at sustained inflation. The maximal impulse frequency of the phasic response was 59/s. The frequency of the tonic afferent impulses was near the empty level until the volume of injected oil exceeded 3 μl, then it increased linearly with the logarithm of the volume. The maximal volume injected was 16 μl. The mate-refusal response was artificially induced in a virgin female when more than 4 μl oil was injected into its bursa copulatrix. Moreover, it was found by interruption of copulation that the female never refused to remate unless the bursa contents exceeded half the normal spermatophore volume. These results strongly suggest that the tonic response of the stretch receptor plays a main role in the switchover of the behavior.

3R-2,6 ELECTROANTENNOGRAMS OF THE AMERICAN COCKROACH (*PERIPLANETA AMERICANA*) TO SEX PHEROMONE MIMICS.

Nishino, C. and Takayanagi, H. (Mitsubishi-Kasei Inst. Life Scie., Machida, Tokyo 194, Japan)

Recently, several sexually active plant-derived terpenoids against the American cockroach, which are (+)-bornyl acetate, germacrene-D, (-)-bornyl acetate, and (+)-*trans*-verbenyl acetate, were discovered other than the natural sex pheromone of this insect. Hence, the terpenoids are called as sex pheromone mimics. Electroantennogram (EAG) responses were recorded from the adult male and female of the cockroach, stimulating with the mimics.

We found that the significance of the male to female EAG response ratio (M/F ratio), and have interpreted the significance on the basis of the possible perticipation of the mimics to receptors on the antennae. This paper will be mentioned on the relationships between the ratio and the potency of the behavioral activity of the mimics.

3R-2,7 THE CHEMICAL COMPOSITION OF THE ODORIFEROUS SECRETIONS OF SOME STINK BUGS: ARE THE MAJOR COMPONENTS RESPONSIBLE FOR ITS FUNCTION?

Kitamura,C. and Takahashi,S. (Pesticide Res. Ins., Kyoto Univ.) and Wakamura,S. (Shikoku Agric. Exp. Station)

The chemical composition of the odoriferous ventral secretions of some stink bugs were investigated.

The adults of *Halyomorpha mista* Uhler (Pentatomidae) were seized with forceps on their abdomen. The discharged fluid was collected by glass capillary, dissolved in pentane, and analyzed by gas chromatography and GC-MS equipped with computer. The chromatogram of the secretions from males were identical with that of from females. There appeared eight peaks in the chromatogram. The scent fluid was applied onto the SEP-PAK-cartridge (Waters Associates, Inc.) and eluted with pentane, 5% ether/pentane and ether. From the pentane eluate, five hydrocarbons (corresponding to the C_{11}, C_{12}, C_{13}, C_{14}, C_{15}) were identified by GC-MS (mass spectrum and mass chromatography). Characteristic odour was appeared in the 5% ether/pentane fraction. Three aldehydes and one ester were detected from this fraction, and characterized as 4-oxo-hexenal, decenal, decadienal and decenyl acetate by GC-MS.

The major components were tridecane and decenal, when the analysis was carried out for the glass-capillary-collected secretions. On the contrary, the analysis of the odour adsorbed on Chromosorb 105 showed oxo-hexenal to be the major aldehyde. It is clear that the functional odoriferous compounds were not always the major components of the secretions.

The components of the ventral fluids of some other stink bugs are also discussed.

3R-2,8 IDENTIFICATION OF COMPONENTS OF RECTAL GLANDS IN MALE ORIENTAL FRUIT FLIES AND MELON FLIES.

Ohinata, K., Jacobson, M. (USDA-SEA-AR, Beltsville, MD 20705), Fujimoto, M. and Higa, H. Tropical Fruit and Vegetable Research Laboratory, USDA-AR-SEA, Honolulu, Hawaii 96804.

The major components of oriental fruit fly, *Dacus dorsalis* Hendel, and melon fly, *D. cucurbitae* Coquillett, male rectal glands, believed to be the source of sex pheromone production and storage in these 2 tephritid species, were identified. Substances common to glands of both species were (*Z*)-6-nonen-1-ol and trisodium phosphate. Oriental fruit fly glands also contained propionic acid and small amounts of 7 higher acids and 2-methylbutylamine, while melon fly glands contained 1,3-dimethoxybenzene and 3 minor, unidentified substances.

3R-3,9 RATE RELEASE OF PHEROMONES FROM CONREL FIBERS: EVALUATION OF DETERMINATION METHODOLGY.

Weatherston, J., Huang, Y.Y., Golub, M.A., Benn, M.H. and Brooks, T.W. (Conrel, 110 A St., Needham Heights, MA 02194 USA)

The efficacy of controlled release systems used in pest management strategies depends primarily on the release rate of the active ingredient, and the longevity of the formulation.

Using Conrel hollow fibers containing gossyplure ((Z,Z)-7,11-hexadecadien-1-yl acetate: (Z,E)-7,11-hexadecadien-1-yl acetate (1:1)) the release rate has been determined by:

1. Trapping the effluent vapors on glass substrates in both still and moving air.
2. Chemical extraction and analysis of the residue remaining in the fiber.
3. Observation of meniscus regression within the fiber.
4. Weight loss from the fibers.

The analytical methods used included optical comparison, capillary gas chromatography and radioactive scintillation counting.

The results obtained will be discussed in the light of the many factors which influence release rates.

3R-3,10 STUDIES ON SEX PHEROMONE RELEASE BY OVIPARAE OF THE GREENBUG, SCHIZAPHIS GRAMINUM: EVIDENCE FOR A CIRCADIAN CONTROL.

Eisenbach, J. and Mittler, T.E. (Dept. of Entom. Sci., Univ. of California, Berkeley, CA 94720, U.S.A.)

Adult males of Schizaphis graminum tested on a wire walkway responded to the pheromone released from the metathoracic tibia of oviparae of the species by increasing the rate of antennation when they were within 1 - 2 cm of the pheromone source and by turning before they left the odor zone. Males in the fourth larval instar did not respond.

Oviparae released the pheromone only during the light phase of a daily light-dark cycle. Pheromone release increased to a maximum during the first 5 days of adulthood, remained maximal for a few days, and then declined gradually to zero by day 20 of adulthood. The daily onset of the release is triggered by the initiation of the light phase, and is governed by a circadian rhythm with a free-running period of 25.6 hr under continuous illumination of 15 lx. Daily maxima of pheromone release occurred 4 - 7 hours after lights on.

Whereas pheromone release ceased permanently within 1 hr after mating, previous matings of the males did not affect their responsiveness to the pheromone.

3R-3,11 Characterization and field evaluation of the minor components of the sex pheromone of Euxoa ochrogaster (Guenée).

Struble*, D. L., Arn**, H. and Buser**, H. R. (*Research Station, Agriculture Canada, Lethbridge, Alberta, Canada T1J 4B1; **Swiss Federal Research Station, Wädenswil, Switzerland)

The washes of the sex pheromone glands of calling females of Euxoa ochrogaster (Lepidoptera: Noctuidae) contained seven pheromone-like mono-olefinic acetates. These components were characterized by high resolution gas chromatography coupled directly to a mass spectrometer or an electroantennographic detector. The detector antennae were from male moths of the same species and from other species that were known to be highly sensitive to the suspected minor components of the Euxoa ochrogaster sex pheromone. This technique should find application in pheromone analyses of other species.

The optimum attraction of the male moths in the field was to a blend of four pheromone components in a ratio similar to that found in the female moths. The trap catches were reduced when the concentration of any of the three minor components in the pheromone blend was increased from ca. 1 to 10%. This may be an important general phenomenon in lepidopteran pheromones.

3R-3,12

ROLES OF A PHEROMONE INHIBITOR IN TRAPS AND PERMEATED AROUND TRAPS ON ORIENTATION OF MALE *RHYACIONIA FRUSTRANA*. Schmidt, J. O. and C. W. Berisford (Dept. Ent., Univ. Georgia, Athens, GA, USA)

Male Nantucket pine tip moths, *R. frustrana*, are not captured in traps containing virgin females plus small quantities of the inhibitor (*E*,*E*)-8,10-dodecadien-1-ol acetate, the pheromone of the sympatric species *R. rigidana*. In contrast, when this inhibitatory compound was released from 8 emitters located 4 m from traps containing virgin female *R. frustrana* no reduction in trap catch was observed. When traps containing females plus inhibitor were surrounded by 8 emitters of inhibitor, the trap catch was much higher than from traps containing inhibitor but not surrounded by it and much lower than from traps without inhibitor but surrounded by it. These results indicate that male *R. frustrana* can distinguish between inhibitor present with pheromone in a plume from inhibitor present in the air around a pheromone plume. It furthermore indicates that inhibitor in the air around a pheromone plume partially habituates the male's central nervous system or partially adapts its sensory system resulting in reduced male response to inhibitor in a pheromone plume.

3R-4,13

BIOSYNTHESIS OF THE SEX PHEROMONE OF THE HOUSEFLY, *MUSCA DOMESTICA*. Blomquist, G. J. and Dillwith, J. W. (Dept. Biochem., Univ. Nevada, Reno, Nevada, USA)

Dramatic effects of age and mating on pheromone production were observed in the female housefly, *Musca domestica*. The production of (Z)-9-tricosene, methyl branched alkanes, and the epoxide components of the sex pheromone was initiated about two days after energence to adults. Marked differences were observed in the composition of the cuticular hydrocarbons in mated and unmated females. The biosynthesis of the components of the sex pheromone were investigated using both *in vivo* and *in vitro* techniques. The incorporation of [1-^{14}C] acetate into pheromone by isolated tissue showed that the hydrocarbon components were formed primarily by epidermal cells in abdominal segments two through seven. The incorporation of labelled acetate, palmitate, stearate, and oleate into the saturated and unsaturated hydrocarbons showed that (Z)-9-tricosene (muscalure) was synthesized *de novo* by female insects and the distribution of label was consistent with a pathway in which oleic acid was elongated and then decarboxylated. A comparison of the incorporation of labeled acetate, propionate, and succinate into hydrocarbon indicated that the mono and dimethylalakanes were formed by the substitution of a methylmalonyl-CoA for malonyl-CoA during chain elongation. The incorporation of [1-^{14}C] propionate increased dramatically in female insects two days after adult emergence, whereas this substrate was not efficiently incorporated at any time into male insect. (Supported in part by USDA CRGO grant 7801064 and NSF grant PCM 76-20694).

3R-4,14

INACTIVE TYPE ESTERIFIED BOMBYKOL IN HEMOLYMPH OF FEMALE PUPA OF THE SILKWORM MOTH *Bombyx mori*. Yamaoka,R.,Nishida,J.and Hayashiya,K.(Lab. Biochem.,Kyoto Technical Univ., Kyoto, 606 Japan)

Pheromonal activity was observed in hemolymph of the female pupa after hydrolysis, whereas it was neither observed in the hemolymph before hydrolysis nor in that of the male pupa before and after hydrolysis. The inactive type pheromone(In-Ph) could be extracted with ether and it was also bound to lypoprotein in hemolymph. Daily variation of the pheromonal activity in hemolymph after hydrolysis was examined and the strongest activity (10^{-2}-10^{-3}Female pupal hemolymph/ml, cf. 10^{-4}-10^{-5}FE/ml: Pheromone gland of the adult female moth) was found in hemolymph of the female pupa two days before emergency.

Result of prep. TLC and prep. $AgNO_3$-TLC suggested that the In-Ph might be highly unsaturated wax. The active fraction purified by column chromatography was subjected to gas chromatographic analysis using 5% OV-1 and OV-17 at 300°C, and the eluate was collected according to peaks appeared. Retention index[I] of the In-Ph was I_{300}^{ov-1}3570 and I_{300}^{ov-17}3820(cf.[I] of standard cetyl stearate was I_{300}^{ov-1}3545 and I_{300}^{ov-17}3650). In GC-MS spectrum of the In-Ph and the hydrogenated product, molecular ions were observed at m/z 498 and m/z 508 respectively. Retention time OV-1, OV-17 and MS spectrum of the hydrogenated In-Ph were identical with those of standard cetyl stearate. The In-Ph collected by prep. GC and hydrolyzed in 5% KOH was injected onto GC-MS(SIM) on OV-1 at 200°C using ion 238, M^+ of bombykol,as a monitoring ion. Ion m/z 238 was observed on identical tR with standard bombykol.

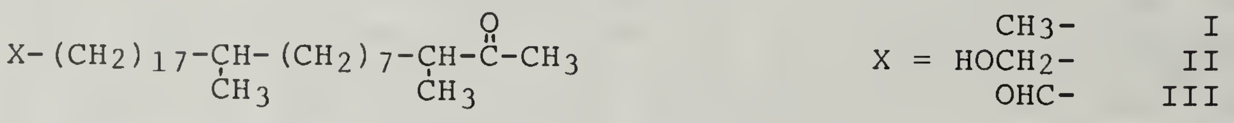
These results indicated that the chemical structure of the Inactive Type Esterified Pheromone was octadecatrienoic acid ester of bombykol. The position and geometric configulation of three double bonds in the octadecatrienoic acid are under investigation.

3R-4,15

STRUCTURE-ACTIVITY RELATIONSHIP IN FEMALE SEX PHEROMONE ANALOGS OF THE GERMAN COCKROACH.

Nishida,R., Sato,T., Kuwahara,Y., Fukami,H., and Ishii,S. (Pesticide research Institute, Kyoto Univ., Kyoto, 606 JAPAN)

Three components I, II and III were characterized as female sex pheromone of the German cockroach, *Blattella germanica* (L.), responsible for male wing-raising behavior. More than seventy analogs of these pheromones were synthesized systematically by substitution of X, replacement or movement of the side chains, elongation or shortening of the main chain, alteraion of the carbonyl group and combination of these modifications. Their pheromonal activity was examined in relation to the molecular characteristics. A wide variety of the analogs was found to be active, some of which showed much higher activity than naturally occuring ones.



$$X\text{-}(CH_2)_{17}\text{-}\underset{CH_3}{CH}\text{-}(CH_2)_7\text{-}\underset{CH_3}{CH}\text{-}\overset{O}{\overset{\|}{C}}\text{-}CH_3 \qquad X = \begin{array}{lc} CH_3\text{-} & I \\ HOCH_2\text{-} & II \\ OHC\text{-} & III \end{array}$$

3R-5,16

SOME DIETARY REQUIREMENTS OF THE RICE GREEN LEAFHOPPER, *NEPHOTETTIX CINCTICEPS*.

Lin, L. C., and Hou, R. F. (Dept. Ent., Nat. Chung Hsing Univ., Taichung, Taiwan, ROC)

Dietary requirements of the rice green leafhopper, *Nephotettix cincticeps*, for amino acids and cholesterol were studied by feeding on a holidic diet. Deletion of arginine or phenylalanine among 10 'essential' amino acids exhibited no detrimental effect on nymphal growth and adult emergence of the leafhopper, but omission of methionine caused 100% nymphal mortality. The leafhoppers can be reared on a diet containing 23 amino acids, but they are unable to live on the diet with 10 'essential' amino acids only.

Group deletion of aspartic acid, asparagine, glutamic acid, and glutamine; or glutamine; or cysteine and cystine; or cysteine, cystine, and methionine from diets supported poor development. Deprivation of proline from 13 'non-essential' amino acids did not markedly affect the leafhopper growth.

Cholesterol was found suitable for the leafhopper growth and development at 5 mg/100 ml. Analysis of the tissue cholesterol revealed that the leafhoppers fed on the diet containing 5 mg/100 ml cholesterol have a content, i.e., 1.789 µg/mg dry wt., similar to those insects from rice seedlings. The results are in support of our feeding standard with this concentration of cholesterol in holidic diets.

3R-5,17

TROPHIC REGULATION OF OVARIAN DEVELOPMENT OF *COCCINELLA SEPTEMPUNCTATA*.

Qin Junde, Zhai Qihui, and Kun Hu (Institute of Zoology, Academia Sinica, Peking, China)

Artificial diets composed essentially of fresh porcine liver and honey were prepared to rear the adult beetles into egg-laying. It was seen that their pre-ovipositing periods were prolonged and less eggs were laid as compared with those feeding on aphids. Quantitative determination of foods eaten by the beetles showed that a female beetle weighing about 30 mg would consume daily 20 mg aphids but only 5 mg artificial diet. After emergence the female beetles feeding on aphids would grow in weight and vitellogenin appeared in hemolymph on the 6th day and oviposition commenced on the 11th day. The beetles feeding on artificial diets would also grow in weight but the protein content of the fat body was low and hemolymph vitellogenin would appear late so that the pre-ovipositing period usually occupied three weeks. But vitellogenin synthesis in the fat body under this condition could be promoted by topical application of juvenile hormone analogue ZR 512 on the abdominal tergites of the female beetles which would increase egg-laying accordingly. Thus the food quality has a conspicuous influence on the ovarian development and increasing food ingestion would not only provide more materials for the fat body to synthesize vitellogenin but also activate the neuro-endocrine system for hormone secretion. Within the population of the beetles collected from North China a few individuals could adapt the artificial diets quite well; their pre-ovipositing periods and the total numbers of eggs laid were very close to those feeding on aphids. Afew could never adapt the diets; they did not grow in weight, nor proceed in ovarian development. The majority would grow in weight but their ovarian development was slow; they showed characteristics of reproductive diapause.

3R-5,18

ROLE OF CERTAIN NON-ESSENTIAL AMINO ACIDS IN PHAGOSTIMULATION, GROWTH AND SURVIVAL OF THE PEA APHID, (ACYRTHOSIPHON PISUM). Srivastava, P.N. (Dept. Biol. Sci., Univ. de Montréal, Montréal H3C 3J7, Quebec, Canada).

Ten non-essential amino acids and amides at different concentrations in 35% sucrose solution were individually tested for their role in phagostimulation, growth and survival of the pea aphid. Alanine was phagostimulatory at all concentrations tested (0.1 - 0.75%), where as glycine and cystine at 0.2 and 0.001% respectively. Asparagine, aspartic acid, cysteine, glutamic acid, glycine, proline, serine and tyrosine reduced uptake when compared to sucrose alone. Alanine, cysteine, cystine and serine did not support growth, where as others supported growth either at one concentration or at all concentrations tested. Some of the radio-active amino acids were incorporated into the protein fraction of the body indicating that they took part in protein synthesis.

3R-5,19

B-COMPLEX VITAMINS AND THEIR ROLE IN ADULT OLIVE FRUIT FLY (DACUS OLEAE) REPRODUCTION AND LONGEVITY. Tsiropoulos G. ("Demokritos" Nuclear Research Center, Aghia Paraskevi Attikis, Athens, Greece)

The role of 9 B-complex vitamins in adult *Dacus oleae* survival, fecundity, and fertility was studied, individually deleting them from an effective chemically defined diet consisted of 47 pure chemicals. Omission of pyridoxine and riboflavin affected survival of both sexes. Egg production and hatchability were significantly reduced with single omissions of biotin, choline chloride, inositol, nicotinic acid, and riboflavin. The other 4 B-complex vitamins: calcium pantothenate, folic acid, pyridoxine, and thiamine, when singly omitted, did not affect fecundity, while they significantly reduced hatchability. Synchronous omission of folic acid and RNA affected both egg production and hatchability as well as female longevity.

3R-6,20

A COMPARATIVE STUDY OF ELEMENTAL PROFILES OF LIFE STAGES OF WESTERN SPRUCE BUDWORM REARED ON ARTIFICIAL MEDIUM AND THREE HOST FOLIAGES. McLean, J.A., and Laks, P.E. (Fac. of For., U.B.C) (read by Angerilli, N.P.D.).

Western spruce budworm were laboratory-reared on artificial medium, or foliage from Grand Fir, Douglas-fir, or Engelmann Spruce. The trace element profiles of the media, foliage, pupae and adults of male and female western spruce budworm were derived by X-ray energy dispersive spectroscopy. A comparison of nutrient levels in each stage will be presented.

3R-6,21 EFFECTS OF VARIOUS COMBINATIONS OF AIR POLLUTANTS ON THE LARGE MILKWEED BUG (ONCOPELTUS FASCIATUS).

Feir, D. (Dept. Biol., St. Louis Univ., St. Louis, MO. 63103 USA.

Comparisons will be made on the results of exposure of the large milkweed bug to 3 experimental protocols using air pollutants: (#1) Each of 3 rooms contained different, computer-controlled levels of the following gas mixture: CO, SO_2, NO, NO_2, CH_4, and $(NH_4)_2SO_4$. One room simulated the levels found in a typical urban environment such as St. Louis, MO., USA; one room contained high or episodic levels, and one room contained exaggerated or emergency levels. A fourth room was the clean air or control' room. All the rooms were temperature and humidity controlled. The basic experiment was conducted for 3 generations. Variations of the basic experiment included exposures for 3/4 of the life cycle instead of the entire life cycle and the stresses of crowding and sub-optimum diet. (#2) One room contained only ozone, the second room contained ozone plus SO_2, CO, CH_4, NO and NO_2 at typical urban levels, the third room contained the same gases as room 2 except there was no ozone, and room 4 was the control. (#3) Individual bugs were placed in petri dishes with gauze replacing most of the top lid and 125 of the petri dishes were placed in a lucite chamber, 40 x 40 x 40 cm. In one experiment the bugs were exposed to a single gas for 2 hours each day throughout the life cycle and in a second experiment the bugs were exposed for 18 hours each day throughout the life cycle. The levels of gas were more difficult to control in this experiment but they were approximately 3 times the levels in the episodic room of experiment (#1). Growth rate, survivorship, and fecundity were measured in all cases.

3R-6,22 Distribution of Sequestered Cardenolides in the Bodies of Some Milkweed Insects.

Nishio, S. and Blum, M. S. (Dept. Ent., Univ. Georgia, Athens, GA 30602 U.S.A.)

Many aposematic insects sequester cardenolides from their food plants (Rothschild, 1972) and these compounds are believed to function as an antipredator device (Brower, 1969, Duffey, 1974 and Reichstein, 1967). Since the distributional pattern of sequestered compounds in body tissues differs from one insect species to another (Black, 1976 and Brower, 1975), a comprehension of the raison d'être of selective sequestration requires a detailed study of the idiosyncratic cardenolide distribution of each species. The metabolism and distribution of stored cardenolides in several insect species (e.g., the monarch butterfly, Danaus plexippus L. and the arctiid Cycnia inopinatus (Hy. Edwards)) will be discussed and the defensive behavior of each species against selected predators analyzed.

3R-6,23 PHYTOALEXIN-INDUCING FACTOR OF THE SWEET POTATO WEEVIL (CYLAS FORMICARIUS)

Sato, K., Uritani, I. and Saito, T. (Dept. Agric. Chem., Nagoya Univ., Nagoya 464, Japan)

Phytoalexins such as ipomeamarone (sesqiterpene) are induced in sweet potato roots, when infested with the sweet potato weevil (Cylas formicarius) or the West Indian sweet potato weevil (Euscepes postfasciatus). Both weevils may be rather immune to the sesqiterpenes produced in sweet potato roots in responce to boring into the tissue. The inducing factor of C. formicarius consists of heat-unstable high molecular weight component(s) which may be glycoprotein(s), and heat-stable low molecular weight component(s). The former component(s) may be an enzyme or some other physiologically active glycoprotein(s) which requires some low molecular weight cofactor. The high molecular weight component(s) was partially purified by ammonium sulfate fractionation, concanavalin A-Sepharose affinity chromatography and gel filtration. The inducing factor of the larvae of E. postfasciatus was heat-unstable high molecular weight substance(s), and active without the addition of the low molecular weight component(s). The inducing factor may not require any low molecular weight cofactor-like substance for the sesqiterpene induction, or may be tightly combined with some cofactor-like substance, as iron-porphyrin moiety of the cytochromes, in the case of E. postfasciatus. These reslts indicate that the biochemical properties of the inducing factor of the larvae of E. postfasciatus are different from those of C. formicarius. The chemical properties and sesqiterpene-inducing mechanism of the inducing factor of C. formicarius will be discussed.

3R-7,24

ULTRASTRUCTURAL CHANGES IN THE EYE DURING LIGHT AND DARK ADAPTATION OF PIERIS BRASSICAE L. (LEPIDOPTERA).

Kolb,G.M.H. and Schwarz,G. (Zoologisches Institut Univ. München, D-8000 München 2, Luisenstraße 14, West Germany)

The complex eye of Pieris brassicae is an apposition eye with tiered retina. Ultrastructural alterations during light and dark adaptation were investigated over the entire length of the ommatidia on the basis of chartings at comparable levels of the ommatidia and reproduced in histograms. The retinular cells play the most significant but not the only role in adaptation. In addition, the accessory and main pigment cells as well as the dioptric apparatus are involved in adaptation. Whereas the distal visual cells show the pupillary reaction in the most distal region, proximal visual cells adapt to light or dark only slightly with horizontal migration of pigment. A slight vertical migration within the retinula cells of a butterfly was registered for the first time. Pigment granules also migrate within the accessory pigment cells especially in their distal processes. The adaptation reactions take place to varying extents in the different regions of the eye.

3R-7,25

PHOTORECEPTION IN EUROPEAN CORN BORER, OSTRINIA NUBILALIS

Patel N. (E.I. du Pont de Nemours & Co. Wilmington, De., U.S.A. 19898),
Skopik S.D. (School of Life and Health Sciences, U. of D., Newark, De. U.S.A. 19711).

The larval diapause in European corn borer, Ostrinia nubilalis, is terminated by a long (16:8,L:D) and maintained by a short (12:12,L:D) photoperiod. It is crucial to find the photoreceptor site and the molecule to understand how the initial photpreception modulates the subsequent endocrine events and leads to pupation, a diapause termination criterion frequently employed. The experimental details and results on the photoreception site and a photosensitive molecule will be presented.

3R-7,26

CORRELATION OF ULTRASTRUCTURAL AND ELECTROPHORETIC DEMONSTRATION OF NEUROSECRETION FROM THE FRONTAL GANGLION AND TERMINAL ABDOMINAL GANGLION OF THE AMERICAN COCKROACH, PERIPLANETA AMERICANA.

Verrett, J., Glover, D., and Nelson, C. (Div. Nat. Sci., Dillard Univ., New Orleans, 70122, U.S.A.)

Ultrsstructural evidence of neurosecretion in the frontal ganglion and in the terminal abdominal ganglion both before and after frontal ganglionectomy has been correlated with electrophoretic bands from samples of the ganglia and of hemolymph. Support has been obtained for the hypothesis that diuresis after frontal ganglionectomy is due in part to loss of the inhibitory influences of the frontal ganglion factor on the release of diuretic hormone from the terminal abdominal ganglion.

3R-8,27 EFFECTS OF CAROTENOID DEFICIENCY ON PHOTOSENSITIVITIES IN THE SILKWORM, *BOMBYX MORI*.

Shimizu, I., Kitabatake, S. and Kato, M. (Environ. Physiol., Faculty of Science, Kyoto Univ., Kyoto 606 Japan)

Eggs of the silkworm were incubated at 25°C during embryonic development, and the larvae were aseptically reared on a well-defined synthetic diet with and without β-Carotene added. In comparison with the larvae which were reared on the β-Carotene supplemented diet, β-Carotene deficiency decreased the larval phototactic response as larvae grew, and finally lost the electric response by light stimulus in visual organs, stemmata and compound eyes. This is probably due to a lack of visual pigment. However, lack of carotenoid did not affect the timing of eclosion which is regulated by a photoperiodic condition during the pupal period. All resulting moths laid diapause eggs if they were given shorter photophase than 16 hr during larval life, and 20 to 50% of moths which were given longer photophase than 20 hr laid diapause eggs. β-Carotene deficiency did not siginicantly affect these results of the diapause induction in next generation.

3R-8,28 DAILY CHANGE OF THE RATE OF HEART BEAT IN THE SILKWORM, BOMBYX MORI L.

Sumimoto, K. (Biol. Lab., Kyoto Tech. Univ., Matsugasaki, Sakyo-ku, Kyoto 606 Japan

Daily change of the rate of heart beat in the 5th instar Bômbyx larva in relation to the photoresponse was studied. The rate of heart beat changed rhythmically with bimodal pattern which consists of two "accelerating phases" and two "decelerating phases". The period of the rhythm was affected by the light condition of the larval stage. Short period less than 12-hours was observed in the experimental group reared under the constant light, and in this case the length of the accelerating phase was nearly equal to that of the decelerating phase. On the other hand, long period more than 12-hours was observed in the experimental group reared under the constant dark, and in this case the decelerating phase was considerably longer than the accelerating phase. Such elongation of the decelerating phase always occurred at the dark phase. Such results suggest that the illumination does accelerate the heart beat. The accelerating phase of new cycle started out just after beginning of the photophase.

3R-8,29 GUT PURGE RHYTHM IN SAMIA CYNTHIA RICINI. I. THE CLOCK AND THE HORMONE SECRETION.

Fujishita,M., Mizoguchi,A. and Ishizaki,H.(Biol. Inst., Nagoya Univ., Nagoya, 464 Japan)

The gut purge timing in Samia cynthia ricini is under the control of a circadian clock. The clock nature and the timing of the prothoracicotropic hormone(PTTH) and ecdysone release were analyzed. The emphasis will be made on the evidence showing that the clock that determines the gut purge timing controls a process closely associated with ecdysone release well after PTTH has become unnecessary.

3R-9,30 GUT PURGE RHYTHM IN SAMIA CYNTHIA RICINI. II. RELATION TO ECDYSONE SECRETION.

Fujishita, M. and Ishizaki, H. (Inst. Biol., Facul. Sci., Nagoya Univ., Nagoya 464, Japan)

Pupation of Samia cynthia ricini is preceded by two peaks of haemolymph ecdysteroid as Manduca sexta and other insects, small one a few hours before gut purge and the other one 2 days before pupal ecdysis. When the light-off preceding the gut purge was phase-shifted, the gut purge timing as well as the first ecdysteroid peak was phase-shifted. Injection of ecdysone or ecdysterone within a limitted range of time before gut purge caused precocious gut purge a fixed time after the injection. The results are consistent with the idea that the clock determines the gut purge timing by controlling a process closely associated with the first ecdysteroid peak.

3R-9,31 GUT PURGE RHYTHM IN SAMIA CYNTHIA RICINI. III. THE PHOTORECEPTOR SITE.

Mizoguchi, A. and Ishizaki, H. (Biol. Inst., Nagoya Univ., Nagoya, 464 Japan)

By means of local illumination in light-pulse perturbation of DD free-running gut purge rhythm, efforts were made to locate the site of photoreceptor that was associated with the clock involved in determination of gut purge timing. The thorax, rather than the head, was sensitive to light. The ventro-lateral broad area of the meso and metathorax was particularly sensitive. A possible site of the photoreceptor and clock will be discussed.

3R-9,32 ON THE ROLE OF THE CAPILLARY ATTRACTION IN FEEDING OF THE SUCKING INSECTS

Glumac,S.(Institute of Biology,Faculty of Natural Science,Novi Sad,Yugoslavia)

The width of the alimentary canal of the bloodsucking insect species (Culex pipiens L.) was studied in the experiments on possible effect of capillary attraction upon the insect feeding. The width of proboscis lumen measured 55 μ ,pharyngeal enlargement 300 μ ,and intestinum ranged from 40 to 80 μ . Values mentioned above were within the limits of those of capillary width.Closing of the mouth parts results in capillary attraction and water column in the capillary of mentioned width would,according to the equation (1),measure 29.56 cm that,on the other hand,exceeds considerably the total length of insect alimentary canal. If one take into consideration the blood pressure in human capillary system (arterial - 40 cm,veinal - 16 cm of water column), the problem of limited blood transport into the alimentary canal due to lumen expansion within the capillaries and the formation of the capillaries from the proboscis part is rather present than sucking in usual manner. The pharyngeal enlargement indicated by the histological structure would act as siphon rather than a pump. Similar results were obtained in Aphididae,and feeding of Coccidae is based on the same phenomenon.

(1) $\gamma = \frac{1}{2} \rho g h r \qquad h r = \frac{2\gamma}{\rho g} \qquad h = \frac{\frac{2\gamma}{\rho g}}{r}$

γ - surface tention, ρ - viscosity, g - gravity, h - column height, r - radius

3R-10,34

BIOSYNTHESIS OF NORMAL AND METHYL BRANCHED ALKANES IN THE TERMITE *ZOOTERMOPSIS ANGUSTICOLLIS*. Chu, A. J. and Blomquist, G. J. (Dept. Biochem., Univ. Nevada, Reno, Nevada, USA)

In vivo and *in vitro* experiments were performed to study the biosynthesis of hydrocarbons in the termite *Zootermopsis angusticollis*. Radio-GLC of the alkanes formed from the metabolism of [15,16-^{3}H] tetracosanoic acid both in intact animals and in cell free preparations showed that the substrate was directly decarboxylated to *n*-tricosane. α-Hydroxytetracosanoic acid was decarboxylated more efficiently then was tetracosanoic acid, suggesting that the first step in the reductive decarboxylation was α-hydroxylation. The decarboxylase activity was located primarily in the microsomal fraction, and was stimulated two fold by the addition of ascorbic acid. The pH optimum for the reaction was 6.0. Neither ATP, CoASH, nor reduced pyridine nucleotides increased enzyme activity. [2,3-^{14}C] Succinate was incorporated into both the normal and methyl branched components in accord with the mass distribution of each component. In contrast, [1-^{14}C] succinate was preferentially incorporated into the normal alkanes of this insect and [2,3-^{3}H] succinate was preferentially incorporated into the methyl branched alkanes. Malonate markedly inhibited the incorporation of succinate into hydrocarbon and changed the distribution of radioactivity from [2,3-^{14}C] succinate such that the methyl branched hydrocarbons were preferentially labeled. Incorporation of dual labeled [1-^{14}C,2,3-^{3}H] succinate resulted in the methyl branched hydrocarbons having a higher ^{3}H/^{14}C ratio than the normal alkanes. Addition of malonate further increased this ratio. These data are consistant with a pathway in which succinate is converted to methylmalonyl-CoA and is subsequently incorporated into methyl branched hydrocarbons. (Supported in part by USDA CRGO grant 7801064 and NSF grant PCM 76-20694).

3R-10,35

PATTERNS OF URIC ACID VOIDING AND STORAGE IN COCKROACHES. Cochran, D. G. (Dept. Entomol., Va. Polytech. Inst. & State Univ., Blacksburg, VA 24061, USA).

Uric acid is the most common nitrogenous excretory product of insects. It is normally excreted by the Malpighian tubules and is voided to the exterior admixed with the digestive wastes. This pattern of handling uric acid is apparently very rare in cockroaches. Some members of the genus *Ishnoptera* may void uric acid in this manner. However, the most common situation among about 75 species examined is that uric acid is not voided to the exterior, but rather is stored extensively in fat body urate cells. The amount of uric acid stored is directly related to the level of dietary nitrogen. In addition, some members of the subfamily *Blattellinae* store but also void uric acid to the exterior as formed pellets which contain a high level of uric acid. Excretion of uric acid by this means is variable depending on species, age, and dietary levels of nitrogen. These variations can be manifested in the number of pellets voided per individual per unit time as well as by the amount of uric acid per pellet. Uric acid is also voided by the males of some species which pour urates from the accessory glands over the spermatophore at the time of mating. From this work it is clear that cockroaches do not handle uric acid as a typical nitrogenous excretory product. Rather the extensive storage of urates in the metabolically active fat body appears to indicate a useful role for this chemical (perhaps mediated by mycetocyte bacteroids). This theme may be repeated in urate pellet formation and accessory gland voiding of urates. Even the *Ishnoptera* pattern appears to be atypical because of the small amount of uric acid voided. Conceivably, the latter might represent an evolutionary link to the usual insect uric acid excretory pattern.

3R-10,37

CAROTENOIDS CONTENT DURING THE LIFETIME OF THE COLORADO-BEETLE /*LEPTINOTARSA DECEMLINEATA* SAY./ B. Czeczuga /Dept.Gener.Biol.,Med.Acad.,15-230 Białystok, Poland/

The author investigated by means of columnar and thin-layer chromatography the carotenoids in the leaves of the potato-plant and in eggs, larvae, pupae and imagines of the colorado-beetle. The following carotenoids were identified: β, γ-carotene, β-zeacarotene, β-carotene epoxide, canthaxanthin, β-cryptoxanthin, lutein, zeaxanthin, astaxanthin and mutatochrome. The results are discussed in the light of the assimilation of carotenoids with food by colorado-beetle.

3R-11,38

PROLINE SYNTHESIS FROM GLUTAMATE IN A BLOWFLY, ALDRICHINA GRAHAMI. Wadano, A. and Miura, K. (Laboratory of Biochemistry, Department of Agricultural Chemistry, University of Osaka Prefecture, Sakai-City, Osaka, 591 Japan)

A. blowfly, Aldrichina grahami, has a potent proline synthetic activity from glutamate in the adult atage(Yoshida et al., 1977). The biosynthetic activity was demonstrated in a cell free system prepared from abdomen of the blowfly. Subcellular fractionation of the cell free system revealed that the proline biosynthetic activity resides in the mitochondrial fraction. The biosynthesis required ATP, NADPH and Mg^{++} as cofactors; NADH could partially replace NADPH. The mitochondrial fraction and the cytosol fraction contained about the same level of glutamyl kinase activity. The mitochondrial kinase is presumably involved in the biosynthetic pathway from proline, while the kinase in the cytosol fraction apparently catalyzes the synthesis of glutamine.

3R-11,39

STRUCTURAL AND ENZYMIC CHANGES IN FAT BODY MITOCHONDRIA OF THE BLOWFLY, ALDRICHINA GRAHAMI, DURING LARVAL GROWTH. Tsuyama, S. and Miura, K. (Laboratory of Biochemistry, Department of Agricultural Chemistry, University of Osaka Prefecture, Sakai-City, Osaka, 591 Japan)

Changes in the properties of fat body mitochondria from the blowfly during larval growth were examined by electron microscopy and enzyme assay. Early in the last instar, the fat body contained many large mitochondria (1.5μm i.d.) with a mean buoyant density of 1.19. After the larva stopped eating, the number of fat body mitochondria decreased, their size was reduced (1.0μm i.d.) and their mean buoyant density became 1.23. The two mitochondrial populations were demonstrated in the larval fat body by differential centrifugation and by membrane filtration. The relative amounts of the two populations were dependent on the age of the larvae. And the leakage of ornithine aminotransferase from the small mitochondrial matrix was found in the washes. The appearance of the small mitochondria are likely to be due to mitochondrial degeneration. The greater density of the smaller mitochondria compared with the larger may be due to the increased 'leakiness' of the organelles with the age of the larvae causing an increase in the accessibility of the matrix space to sucrose.

3R-11,40

GLYCOLYTIC INTERMADIATES AND NUCLEOTIDES IN THE LARVAL BLOOD AND TISSUES OF THE SILKWORM (BOMBYX MORI), Yanagawa, H. (Sericult. Exp. Sta., Ibaraki 305, Japan)

Glycolytic intermadiates and adenine nucleotides in the larval blood, fat body, midgut, and muscle of the silkworm were analyzed. Trehalose, glucose, glucose 6-phosphate, fructose 6-phosphate, fructose 1, 6-diphosphate, dihydroxyacetone phosphate, α-glycerophosphate, glyceraldehyde 3-phosphate, 3-phosphoglycerate, 2-phosphoglycerate, phosphoenolpyruvate, pyruvate, lactate, ATP, ADP, and NAD^+ were measured enzymatically. A high concentration of trehalose was found in the blood and fat body, whereas glucose was found mainly in the blood and midgut. α-Glycerophosphate was accumulated in the blood, and lactate was detected at a high concentration in the muscle. Mass action ratios of glycolytic reactions in the larval tissues were calculated, and rate-limition steps in the glycolysis were discussed. On the other hand, the anaerobic condition produced significantly higher concentrations of lactate and pyruvate in those larval tissues than the aerobic controls. A higher concentration of α-glycerophosphate was also found under the anaerobic condition in the muscle and fat body. In the starved larvae, glucose, glucose 6-phosphate, and fructose 6-phosphate were rapidly decreased in the blood and midgut. However, trehalose was slightly increased in the blood, muscle, and fat body during 8-hour starvation.

3R-11,41 TREHALOSE IN THE SILK GLANDS OF THE SILKWORM, BOMBYX MORI.

Shimada, S., Kido, M., Kamada, A. and Asano, S.(Lab. Agr. Chem.Res., Otsuka Pharmaceutical Co., Ltd., Tokushima 771-01 Japan)

Trehalose was shown to be the principal sugar in the silk glands of the silkworm, Bombyx mori. The accumulation of trehalose occurred along with the growth of silk glands during the fifth instar and reached a maximum immediately before spinning the cocoon. The trehalose content decreased with the histolysis of the silk glands. When larval development was regulated by the application of methoprene with juvenile hormone activity, the trehalose accumulation in the silk glands occurred according to their development.

3R-12,42 An ultrastructural study of degeneration of the flight muscles of the vetch aphid Megoura viciae Buck.

Bruce Johnson, Dept. Zoology, Univ. Tasmania, Australia.

The voluminous indirect flight muscles of the vetch aphid begin to break down within two days of the insect settling on a new host plant. The thick myosin filaments and the M bands disappear first, then the Z bands, while the thin actin filaments persist in the cytoplasm. The mitachondria become sequestered into cytosegresomes where they are digested. As muscle breakdown proceeds the number of residual bodies in the cytoplasm increases. The muscles become reduced in volume as portions of them become pinched off and lost into the surrounding medium. Finally all that remains is the basement layer of the sarcolemma and the tracheae and tracheoles and these persist until the insects die.

3R-12,43 SOME EXTERNAL AND INTERNAL FACTORS CONTROLLING INDIRECT FLIGHT MUSCLE DEGENERATION IN DYSDERCUS CINGULATUS (PYRRHOCORIDAE).

Nair, C.R.M. AND Prabhu, V.K.K. (Dept. Zool., Kerala Univ., Kariavattom, Trivandrum 695 581, India)

In Dysdercus cingulatus, indirect flight muscles grow till day 3 after eclosion. Histolysis starts thereafter and is complete in 7 day old mated and fed females by which time the first batch of eggs are laid. Histolysis of the flight muscles occurs only in 40% of fed virgin females. Starved virgin females retain the flight muscles but mating induces degeneration in 75% of starved females. Feeding sucrose solution alone, has the same effect as starvation. Partial degeneration also occurs after ovariectomy. In males, the flight muscles do not degenerate normally, but do so when the juvenile hormone analogue Kinoprene (courtesy, Dr. G.B. Staal) is applied. In starved virgin females also the flight muscles degenerate when Kinoprene is applied, though their controls do not. Extirpation of the median neurosecretory cells of pars intercerebralis also leads to degeneration of the flight muscles but this effect is mediated through the corpus allatum. Degenerated indirect flight muscles in this animal do not regenerate. Degeneration of the flight muscles in this animal has also genetic basic.

3R-12,44

INSECT SPERM DYNEIN. Baccetti, B., Burrini, A.G., Dallai, R. and Pallini, V. (Institute of Zoology, University of Siena, Italy)

Motility of the axoneme of cilia and flagella is due to the contractile ATPase dynein. The properties of this enzyme have been most extensively studied in sea urchin sperm flagella and in Protozoan and Mollusc cilia; in these systems, at least two isoenzymic forms of dynein are detected, one of which is localized in the outer doublet arm; a localization in some hitherto unidentified axoneme structure is also suspected. In this report, insect sperm dynein is characterized from a biochemical standpoint and shown to represent the only Triton-insoluble ATPase even in insect sperm endowed with complex peri-axonemal structures. In addition, modified spermatozoa of some insect species, precisely lacking some of the axonemal fine structures, have been studied in order to establish a relationship between dynein forms and axonemal organelles.

Unlike all other sperm, scale insect spermatozoa consist of bundles of single microtubules showing projections and capable of sustaining active motility; a dynein-like protein is shown to be present in these sperm and its properties are compared with those of a nucleotide-triphosphatase which occurrs in association with single microtubules of somatic cells.

3R-12,45

LAST LARVAL INSTAR OF 7 LEAF- AND DIET-REARED NOCTUIDAE: CHANGES IN HAEMOLYMPH PROTEIN CONTENT AND HAEMOLYMPH PROTEIN AND GLYCOPROTEIN ELECTROPHEROGRAMS. Vanhaecke, M. and Degheele, D. (Fac. Agricultural Sciences, Coupure 533, B-9000 Gent, Belgium).

Haemolymph proteins of 7 noctuid species were analysed by polyacrylamide gel electrophoresis throughout the last larval instar. The amount of protein in the sample required for an optimal resolution of the haemolymph proteins was 500 ug for Agrotis segetum Denn. et Schiff., 400 ug for Noctua pronuba L.,530 ug for Noctua comes Hbn, 355 ug for Amathes c-nigrum L. and 600 ug for Mamestra brassicae L., Mamestra oleracea L. and Phlogophora meticulosa L. respectively. A correlation between the average haemolymph protein concentration in A. segetum, N. comes, A. c-nigrum, M. oleracea and P. meticulosa and caterpillar color or nutrition was observed. In most noctuids studied haemolymph protein content increased progressively towards the end of the instar. No apparent changes occurred in the protein and glycoprotein patterns of N. pronuba, N. comes, A. c-nigrum, M. brassicae, M. oleracea and P. meticulosa. Quantitative phase-bound differences however did occur. A basic protein and glycoprotein pattern for every species studied was made. Nutrition and caterpillar color did not alter the basic haemolymph protein and glycoprotein pherogram of A. segetum, N. comes, A. c-nigrum, P. meticulosa and M. oleracea.

3R-13,46

THE JUVENILE HORMONE CYTOSOL RECEPTOR IN THE FAT BODIES OF VITELLOGENIC FEMALES OF LEUCOPHAEA MADERAE. Engelmann, Franz (Dept. of Biology, University of California, Los Angeles, California 90024)

In the cockroach Leucophaea vitellogenin synthesis in the fat bodies is controlled exclusively by juvenile hormone (JH). We may therefore assume that JH is bound to a specific cytosol receptor which may serve as a vehicle in transducing the hormonal information prior to the observed transcriptional events. In search for such receptors the fat bodies of vitellogenic females were homogenized in the presence of protease and esterase inhibitors. The post-mitochondrial supernatant was centrifuged at 150,000 g for 60 minutes. JH binding molecules were detected in this supernatant using the charcoal binding assay. Two binding components could be determined, one with a K_D of about 5×10^{-9}, the other of approximately 5 to 7×10^{-8}. Cold JH-III at 100-fold excess competed effectively. Heating at 65°C for 3 - 5 minutes abolished the binding capacity for JH. The compound with high affinity for JH-III eluted from a Sephadex G-100 column in the void volume. Approximately the same K_D value was calculated as before fractionation. A compound with relatively low affinity (K_D of 5×10^{-8}) to JH-III was also identified in hemolymph of adult females and in cytoplasm of nymphal fat bodies. It is concluded that the high affinity compound of the female fat bodies is very likely the JH specific cytosol receptor.

3R-13,47 JUVENILE HORMONE CONTROLS COMPETENCE OF THE OVARY TO RESPOND TO A BRAIN HORMONE IN AEDES AEGYPTI.

Shapiro, J.P. and Hagedorn, H.H.

3R-13,48 HORMONAL REGULATION OF OVARIAN DEVELOPMENT IN TWO AUTOGENOUS MOSQUITOES.

Fuchs, M.S., Kelly, T.J. and Whisenton, L.R. (Dept. Biol., Univ. Notre Dame, Notre Dame, IN 46556 U.S.A.)

Aedes atropalpus and Toxorhynchites brevipalpis are autogenous mosquitoes. Females will undergo at least one complete gonadotropic cycle without a blood-meal or ingestion of any protein source. Decapitation shortly after adult eclosion prevents subsequent ovarian development in both species. Partial restoration can be achieved when the decapitated females receive either juvenile hormone (JH) or 20-hydroxyecdysone in abnormally high doses. These results are probably artifactual because when decapitated females are treated first with JH I followed by 20-hydroxyecdysone, each administered in physiological amounts, ovarian development is induced. We conclude that both hormones are normally required for successful oocyte maturation in these mosquitoes.

3R-13,49 NONMUTAGENIC REGULATORS OF INSECT REPRODUCTION.

Bořkovec, A. B. (Insect Reprod. Lab., USDA, Beltsville, MD 20705 USA)

In distinction to mutagens that alter the genetic system in the gametes or in reproductive organs, nonmutagenic regulators can affect the insect's hormonal systems, the production of cuticle or other synthetic processes required for normal reproduction. Analogues of juvenile and molting hormones administered to adult females interfere with the oogenesis but have no effect on the fertility of males. Precocenes, which prevent the synthesis of juvenile hormones by affecting the function of corpora allata also affect only females. Chitin synthesis inhibitors exert their inhibitory effects on embryogenesis but they may also interfere with the mating capacity of males. Substituted diaminotriazines and benzylphenols hinder ovarian development but their specific physiological effects have not been linked directly with the hormonal regulatory systems or with cuticle formation.

3R-14,50 INDUCTION OF DIAPAUSE IN TROGODERMA GRANARIUM LARVAE.

Aggarwal, Ved Prakash; Saxena, D.M. and Agarwal, H.C. (Dept. of Zool., Univ. of Delhi, Delhi, India)

The larvae of Trogoderma granarium undergo quiescence when their population density is high at temperatures below 30°C. This phenomenon has been termed as weak facultative diapause by Burges(1959). However, the manner in which the high population density induces diapause in this insect is not known and hence studied.

The contact ensured through vision, vapours from the dense cultures and various bristles on the body was not adequate to induce diapause. Individual larvae, when kept in vials which had contained crowded populations of larvae in diapause, themselves were induced into diapause. Extracts of such vials in diethyl ether or ether washings of the body surface of larvae in diapause also induced diapause in individual larvae. Thus thefactor/s required for diapause induction is/are perhaps lipoid in nature and released on the body surface of the larvae. Purification and identification of the factor/s is in progress. It was also found that the younger larvae (10 day old) required much shorter exposure to diapause inducing conditions for diapause induction. As the age advanced, the exposure time required also increased until no diapause was possible in larvae older than 15 days.

3R-14,51 PHYSIOLOGICAL DISTINCTION BETWEEN AESTIVATING AND HIBERNATING ADULTS OF COCCINELLA SEPTEMPUNCTATA BRUCKII MULSANT.

Sakurai, H. and Takeda, S. (Lab.Ent.,Gifu Univ.,Gifu,504 Japan)

First generation adult C. septempunctata aestivates during summer, while the second generation adult hibernates during winter. In both aestivating and hibernating females, ovarian growth was lacking and the respiration rate and protease activity decreased greatly. Histological study showed that corpus allatum function was completely suppressed in aestivating females, but not completely in hibernating females. Application of a juvenile hormone analogue to an aestivating female or transferance of a hibernating female to the 25°C rearing conditions resulted in ovarian maturation and conspicuous increase of protease activity and respiration rate. Results suggested that the aestivation of this species is the true diapause while the hibernation is not.

3R-14,52 PRINCIPLES OF FREEZING-TOLERANCE IN WINTERING INSECTS.

Asahina, E. (Minami 5, Nishi 24, Sapporo, 064, Japan)

Cold resistance in wintering insects is chiefly a matter of the avoidance of freezing (Wigglesworth, 1965). Freezing of insect body, as a rule, brings about serious injuries in many of the insects. However, a variety of insects in various developmental stages have been observed to be freezing-tolerant. They can survive ice formation in the body cavity without postthawing injury if the freezing is not too severe or too prolonged. Many of them accumulate polyhydric alchohol(s) or other small morecule compound(s), which is assumed to be effective protectant(s) against freezing injury, with the approach of the cold season. An exposure to cold environmental temperatures in wintering insects has long been believed necessary to induce freezing-tolerance. However, some insects were proved to become freezing-tolerant even at constant warm temperatures. Many insects exhibit freezing-tolerance usually after entering diapause, while some can survive freezing even in active growing stages.
In the present paper the role of these factors above described in producing insect freezing-tolerance will be discussed.

3R-15,53 EFFECT OF DEBRAINING ON GLYCEROL FORMATION IN PAPILIO MECHAON PUPAE. Shimada, K.(Inst. Low Temp. Sci., Hokkaido Univ., Sapporo, 060 Japan)

Glycerol contents in the hemolymph of diapause pupae slightly increased during the storage at 22°C. The accumulation of glycerol was significantly stimulated by cold at 5°C. On the other hand, glycerol was scarcely detected in the hemolymph of non-diapause pupae stored at 22°C. Brain removal within 24 hrs after pupation resulted in the arrest of development of non-diapause pupa. In the debrained non-diapause pupae, glycerol contents slightly increased during the storage at 22°C. The accumulation of glycerol was also stimulated by cold. However, the glycerol levels in debrained non-diapause pupae were always lower than those in diapause pupae. Glycerol levels and some physiological differences between diapause and debrained non-diapause pupae are discussed from a viewpoint of hormonal control of insect diapause.

3R-15,54 REGULATION OF GLYCEROL IN THE RICE STEM BORER (CHILO SUPPRESSALIS WALKER) Tsumuki, H. (Lab. Appl. Ent., Okayama Univ., Kurashiki, 710 Japan

Glycerol production occurred in hibernating larvae of the rice stem borer and the change of the concentration in haemolymph was closely related to the onset of diapause. The ligation between thorax and abdomen at the pre-diapausing stage caused increased glycerol concentration in haemolymph of the isolated abdomen but at the post-diapausing stage no significant difference in glycerol concentration was observed after the ligation. Furthermore, glycerol formation was stimulated by low temperature and JHA application and inhibited by high temperature and ecdysterone application. Consequently, glycerol may be regulated by both of environmental temperature and endocrine organs in this insect.

3R-15,55 REGULATION OF PHOSPHORYLASE ACTIVATION AT DIAPAUSE INITIATION IN SILKWORM BOMBYX EGGS. Suzuki,K.and Miya,K. (Lab.Appl.Ent.,Iwate Univ.,Morioka,020 Japan)

Glycogen phosphorylase in diapause eggs of the silkworm, Bombyx mori, was studied with enzymatic and histochemical assays. An increase of phosphorylase 'a' activity and a sudden degradation of glycogen occurred at diapause initiation. This activation was dependent upon 'a' enzyme synthesis rather than conversion of 'b' to 'a' by phosphorylase kinase. Phosphorylase reaction was demonstrated histochemically in the yolk cells of eggs at diapause initiation, but not found in the yolk cells of non-diapause eggs in same age. Glycogen degradation also occurred concurrently in the yolk cells of diapause eggs.

Increased phosphorylase 'a' suggests the de novo synthesis in the yolk cells of diapause eggs and it's synthesis may be inhibited or not stimulated in those of non-diapause eggs at early embryonic development.

3R-16,56 TISSUE WATER PATTERNS AFTER FRONTAL GANGLIONECTOMY IN THE FEMALE AMERICAN COCKROACH, PERIPLANETA AMERICANA.

Verrett, J., and Green, K. (Div. Nat. Sci., Dillard Univ., New Orleans, La. 70122 U.S.A.)

The high mortality rate of American cockroaches after frontal ganglionectomy has been shown to be due to severs diuresis. The hypothesis that water becomes trapped in specific body compartments, thereby preventing equilibration with hemolymph water content is discussed in the present report. A comparison is made of transmembrane water movements using tritiated water which was ingested versus that which was injected directly into the hemocoel of normal and frontal ganglionectomized cockroaches. Strong evidence exists that differential cellular permeability properties of internal organs is a contributor to the diuresis seen after ganglionectomy. Hormonal and other biochemical mechanisms are under active investigation.

3R-16,57 NEUROSECRETORY PARS INTERCEREBRALIS CORPORA CARDIACA SYSTEM AND REGULATION OF WATER BALANCE IN THE NYMPHS OF THE DRAGONFLY, ORTHETRUM CHRYSIS (SELYS) (ODONATA)!

Thakare, V. K. and Tembhare, D. B. (Dept. Zool., Nagpur Univ., Nagpur, 440010 India)

Total body water content in the nymph of the dragonfly, Orthetrum chrysis is apparently capable of regulation in the experimental hypotonic as well as hypertonic external media.

Histological studies on the neurosecretory pars intercerebralis-corpora cardiaca system at various salinities provide evidence of involvement of the medial neurosecretory A-cells in the hyper-regulation of water balance.

This is further confirmed by experiments envolving extirpation of pars intercerebralis and administration of aqueous extract of corpora cardiaca that the system is producing a diuretic factor.

3R-16,58 ENERGY CHARGE ANALYSIS OF CICADA'S HOST AND ENDOCYTOBIONTS!

W. Schwemmler (Inst. Pflanzenphysiol./Zellbiol., Freie Univ., 1 Berlin 33, BRD)

The energy charge (ATP, ADP, AMP) of the host and the intracellular symbionts (endocytobionts) of an egg system (cicadas) was determined. It can be regarded as possible evidence for an endogenous, regulative coupling of the energy metabolism of the host egg with that of its egg symbionts. It is known that there is also a tight metabolic correlation between the nucleus-cytoplasm system of a cell and its DNA-containing organelles (mitochondria). Such analogies between endocytobionts and DNA-organelles can be explained by the endosymbiont theory (EST) of the origin of eukaryotic cell. However, even if the EST should be disproved, insect endocytobioses are suitable models for the biochemical analysis of the eukaryotic system.

3R-16,59

NUTRITIVE VALUE OF SOME EDIBLE INSECTS. Conconi J. Ramos Elorduy and Pino Moreno J. M. (Instituto de Biología, Universidad Nacional Autónoma de México, Apartado Postal 70-153, México 20, D. F.)

The nutritive value of 56 insects customarily eaten by large groups of people is presented through a protein analysis.

All the species have a great quantity of proteins in dry basis.

Protein content in differents species ranged in Orthoptera order between 42.42% to 78.24%, in Lepidoptera order between 30.88% to 71% , in Coleoptera order between 54.31% to 70.92% , in Hymenoptera order between 9.45% to 81.69% , in Hemiptera order between 36.82% to 71.52% , in Homoptera order between 44.84% to 72.02%, in Diptera order between 35.90% to 76.94% and in Isoptera order between 36% to 52.44%.

The highest protein content of the mexican edible insects belong to *Proarna* sp. (Homoptera-Cicadidae).

3R-17,60

INSECT COLLAGEN MOLECULES. Ashhurst, Doreen E. (Dept. of Structural Biology, St. George's Hospital Medical School, Univ. of London, Tooting, London SW17 0RE, England).

Biochemical and electron microscopical investigation of collagen extracted from the layer of connective tissue surrounding the ejaculatory duct of the adult male locust, *Locusta migratoria*, has revealed the presence of two types of collagen. The major component is fibrous, the mincr a form of basement membrane collagen (Ashhurst and Bailey, 1980).

Segment-long-spacing crystallites and reconstituted fibrils have been made from the fibrous collagen and the banding patterns are identical with those of crystallites and fibrils made from mammalian Type I collagen and other invertebrate collagens. These results indicate that all these molecules are the same length and have a similar distribution of polar amino-acids.

Similarities are also seen in the amino-acids and cross-links, but the cyanogen-bromide peptides of the locust molecule are unique. The molecule has three identical αchains, that is, it is a trimer in common with other invertebrate collagens, whereas the mammalian Type I collagen molecule is composed of two identical $\alpha 1$ chains and an $\alpha 2$ chain; a Type I trimer has, however, recently been discovered.

The locust collagen molecule is therefore very similar to the fibrous collagen molecule of other invertebrates and to the mammalian Type I trimer. During evolution, only small conservative changes seem to have occurred in this ubiquitous fibrous protein.

Ashhurst, D.E. & Bailey, A.J. 1980. Eur. J. Biochem. 103 (In Press).

3R-17,61

STUDIES ON LIPIDS AND GLYCOGEN CONTENT DURING DEVELOPMENT OF THE INSECT *MYTHIMNA* (*PSEUDALETIA*) *SEPARATA*(WALKER) V.S.Lomte and S.N.Barhanpurkar(Department of Zoology, Marathwada University, Aurangabad- 431004, India)

The armyworm *Mythimna* (*Pseudaletia*) *separata* (Walker) was reared in the laboratory and total lipid, glycogen, total neutral lipid, total phospholipid, glycerides and cholesterol content were determined during the larval development and larva to pupa transformation of the insect.

The total lipid content increased with age and attained a maximum value in the fourth larval instar and the value declined in the last larval stage whereas the glycogen content increased upto the last larval instar. The increase in glycogen level was found to be very significant in the last larval instar. The decline in both total lipid and glycogen was observed in the pupae of the insect. Total neutral lipid followed the pattern of total lipid. Triglycerides composed maximum part of neutral lipid. In addition to triglycerids, diglycerides were also present but at a lower level. Monoglycerides were found to be in the smallest amount. The phospholipid content increased as the larval development proceeded but a steep decrease in the phospholipid level was observed in the pupae. The decrease was more significant in the male pupae of the insect. The cholesterol content was found to be maximum in the fourth larval instar of the insect.

3R-17,62

FATTY ACIDS OF THE LARVAL STAGES IN THE PINE LEAF GALL MIDGE (*THECODIPLOSIS JAPONENSIS*)

Lee, K. R. (Dept. Biol., Kon Kuk Univ., Seoul, 133 Korea)

The concentration of fatty acids during larval stages in Pine leaf gall midge were analyzed by the Gas chromatography.

Healthy specimens were chosen as samples of each larva stages : larva in gall and larva in soil.

The components consist of 7 fatty acids in homogenate of whole body in the Pine leaf gall midge and the following fatty acids, myristic acid, palmitic acid, palmitoleic acid, stearic acid, oleic acid, linoleic acid and linolenic acid were clearly analyzed.

Palmitic acid, oleic acid and linoleic acid which is present in high concentration of larva in gall and soil, respectively.

Myristic acid and linolenic acid were detected in smaller quantities of the larva in gall and soil stages.

The concentration of fatty acid increased at larva stage in soil compare with larva in gall stages.

3R-17,63

RELATIONSHIPS OF PROTEASES FROM THE MIDGUT EPITHELIUM, PERITROPHIC MEMBRANE AND DIGESTIVE FLUID OF THE SILKWORM, *BOMBYX MORI*.

Eguchi, M., Iwamoto, A. and Yamauchi, K. (Lab. Genet., Kyoto Tech. Univ., Kyoto 606, Japan)

Silkworm proteases in the midgut epithelium (MG), peritrophic membrane (PM) and digestive fluid (DF) were studied in its activity, intracellular distribution, elution pattern on gel filtration and immunological properties. Almost all MG and PM enzymes were recovered in the particulate fractions by differential centrifugation and they were solubilized by some detergents. Similar elution profiles were observed in MG, PM and DF with some differences. One of the three peaks from DF was produced *in vitro* appreciably by incubation of MG with Lubrol WX. Ouchterlony's double diffusion test indicated that the main enzymes from three parts of the gut are identical. Possible mechanisms of the transport and conversion of the enzyme in the alimentary canal are discussed.

3R-18,64

A CANE SUGAR FACTOR, SUPPRESSING ACTIVATION OF PRO-PHENOLOXIDASE IN HAEMOLYMPH OF THE SILKWORM, *BOMBYX MORI*.

Ashida, M. (Dept. Biol., Coll. Gen. Education, Univ. Tokyo, Komaba, Meguro-ku, Tokyo, Japan.

When physiological saline containing cane sugar (reagent grade) was injected into haemocoel of silkworm larva and subsequently haemolymph was collected, phenoloxidase actvivity and clot did not develop in the haemolymph (referred to as CS-haemolymph). The active substance was partially purified from cane sugar as a non-dialyzable fraction and designated as cane sugar factor. The factor exerted its effect only *in vivo*, but not *in vitro*. The factor seems to be a macromolecule and is composed of 72.2% glucose, 2.6% amino acids and 25.3% unidentified substance.

CS-haemolymph showed much lower total haemocyte count than that of normal haemolymph and it was suggested that free haemocytes in haemocoel became sedantary when the factor was injected. Activation of pro-phenoloxidase in plasma of CS-haemolymph was effected by incubation with zymosan, laminarin and cuticular pro-phenoloxidase activating enzyme or homogenization. The activation by these treatments was inhibited by *p*-nitrophenyl-*p*'guanidinobenzoate, suggesting involvement of proteolytic enzyme(s) in the process.

3R-18,65 STEROL BINDING PROTEINS IN CERTAIN INSECTS.

Gupt, Renuka; Agarwal, Nita; Duraiswami, S. and Agarwal, H.C.
Dept. of Zoology, Univ. of Delhi, Delhi, India

Insects require a dietary source of sterols for proper growth and development. The sterols are generally absorbed in the anterior part of the midgut and in some insects in the foregut. The absorbed sterols are released from the gut into the haemolymph and from here they go to the fat body and various other tissues/organs. It is, however, not known as to how they are transported in the blood. Such studies were hence undertaken.

A lipoprotein was detected which binds with cholesterol and β-sitosterol in the haemolymph of *Periplaneta americana*, *Dysdercus koenigii*, *Papilio demoleus* and *trogoderma granarium*. The molecular weight and electrophoretic monility of this lipoprotein was identical in all cases. This lipoprotein was required for the pick up of sterols by the fat body from the haemolymph and the release from the fat body to the haemolymph. The same lipoprotein was also shown to bind with free fatty acid and glycerides. The lipoprotein of one insect could be utilized for release of sterols from the fat body of other insects. It appears that a particular group of lipoproteins is responsible for lipid transport in insects in general.

3R-18,66 BIOSYNTHESIS OF MAJOR HEMOLYMPH PROTEINS (30K PROTEINS) IN THE SILKWORM, *BOMBYX MORI*.

Tomino,S., Fujie,J. and Izumi,S.(Dept. Biol., Tokyo Metropolitan Univ., Tokyo 158 Japan)

Upon gel electrophoresis in the presence of SDS, major protein components of the hemolympn of the last instar *B. mori* larvae migrate to the position corresponding to the molecular weight around 30,000 daltons. A group of these proteins was designated as "30K Proteins" and their molecular properties and biosynthesis were studied. 30K Proteins begin to appear in the hemolymph on the 2nd day of the 5th instar and their concentration in the hemolymph progressively increases during development, being maximum at early pupal stage. In the females, 30K Proteins are also detectable in large quantities in the mature oocytes.

Major components of 30K Proteins were separated and purified from the larval hemolymph (Components 1-5). Antibody prepared against Component 4 reacted with Component 4 as well as 2, suggesting the structural similarities between these components.

The fat body mRNA directed the synthesis of two peptides crossreacting with anti-Component 4 in wheat germ and reticulocyte cell-free systems. When injected into *Xenopus* oocytes, the mRNA encoded at least three immunoreactive peptides whose electrophoretic mobilities were indistinguishable from those of 30K Protein components. The result suggests the possibility of post-translational processing in the fat body to yield 30K Proteins.

The mRNA activity for 30K Proteins is only slightly detectable in the fat body before the 2nd day of the 5th instar. The activity sharply increases and reaches maximum on the 3rd day then declines. The appearance of 30K Proteins in the hemolymph is consistent with the mRNA activity in the fat body at early 5th instar, indicating the regulation of the synthesis of 30K Proteins at pre-translational level in the fat body.

3R-18,67 ANALYSIS OF DROSOPHILA mRNAs BY GRADIENT POLYACRYLAMIDE GELS IN FORMAMIDE.

Chen, P. S.(Dept. Zool., Univ. Zürich, CH-8057 Zürich, Switzerland)

The in vitro labeled RNAs in the imaginal discs, salivary glands and fat body from developing larvae and in the accessory glands from male adults of Drosophila melanogaster were separated on linear gradient acrylamide gels in formamide. The electrophoretic patterns appear to be highly tissue- and stage-specific. Several lines of evidence indicate that many of the visualized radioactive bands are mRNAs: (1) Affinity chromatography with poly(U)-sepharose revealed that the most heavily labeled RNA species contained poly(A) sequences. (2) Drastic alterations of the electrophoretic patterns occurred when the tissues were heat-shocked at 37°C. (3) A distinct correlation between the synthesis of specific proteins and the synthesis of corresponding messages could be observed. (4) Labeling of tissues in the presence of selected inhibitors resulted in the suppression of specific RNA bands.

3R-19,68 THE INDUCTION OF VITELLOGENIN SYNTHESIS IN *LOCUSTA MIGRATORIA* : THE EFFECTS OF JUVENILE HORMONE (JH) *IN VITRO*.

Abu-Hakima, R. and Wyatt, G.R. (Dept. Biology, Queen's Univ., Kingston, Ont. Canada).

Fat bodies isolated from *Locusta migratoria* and maintained in culture medium for up to 5 days remain viable and continue to synthesize proteins including vitellogenin. Fat bodies removed from allatectomized females exposed to a primary injection of ZR-515 *in vivo*, when cultured in medium containing 10 µg/ml ZR-515 *in vitro* synthesize vitellogenin. A higher dose, > 100 µg/ml ZR-515 is required to induce a primary response *in vitro*. These results demonstrate a direct effect of JH on the fat body *in vitro*.

3R-19,69 REGULATION OF VITELLOGENIN SYNTHESIS IN AEDES ATROPALPUS.

Kang, S. H. and Fuchs, M. S. (Dept. Biol., Univ. Notre Dame, Notre Dame, IN 46556 U.S.A.)

In mosquitoes, brain hormone, juvenile hormone(JH) and 20-hydroxyecdysone seem to be involved in vitellogenin synthesis. In an attempt to determine what role each of these hormones play in this process, vitellogenin synthesis in the autogenous mosquito, *Aedes atropalpus*, was studied both *in vivo* and *in vitro*. All three hormones stimulated vitellogenin synthesis. Our preliminary results, using RNA synthesis inhibitors, suggest that both JH and 20-hydroxyecdysone may regulate transcriptional events necessary for vitellogenin synthesis to occur in this insect.

3R-19,70 INDUCTION OF VITELLOGENIN SYNTHESIS IN MALE AND FEMALE *SARCOPHAGA BULLATA* BY 20-HYDROXY-ECDYSONE.

De Loof,A. and Huybrechts,R.(University of Louvain,Zool. Inst.,Louvain,Belgium)

By immunological methods no vitellogenin could be detected in haemolymph of male *Sarcophaga*.Injection of a dose ≥ 1 ng 20-hydroxy-ecdysone made vitellogenin appear in the haemolymph.Juvenile hormone was ineffective in this respect.Injection of 10 µg cycloheximide simultaneously with 20-hydroxy-ecdysone prevented vitellogenin appearing in the haemolymph.In females vitellogenin was already present at emergence,although in low concentrations.Its concentration was highest at day 5,24 h after liver feeding.Injection of 2x100 µg 6-OH dopamine-HCl,a compound which seemed to be a rather selective inhibitor of the release of gonadotrophic hormone from the brain,kept vitellogenin concentration in the haemolymph at a much lower level than in the controls and it arrested vitellogenesis in the 4A-4B stage.20-hydroxy-ecdysone overruled the effect of 6-OH dopa on vitellogenin concentration but it was unable to restore normal vitellogenesis.

3P,1

ROLE OF AIR CIRCULATION THROUGH TRACHEAL SYSTEM OF INSECTS IN THERMAL ADJUSTMENTS. TONAPI, C.T. (Dept. Zool., Poona Univ., Poona - 411007 India)

Over half a dozen insect species from diverse ecological habitats showing a wide range of temperature differences have been studied to assess the integrated role of their spiracles, tracheae, ventilation system and metabolism in relation to their thermal adjustments during active respiration. The spiracular area, tracheal bore and volume, the role of air flow and the rate of oxygen consumption have been assessed. About 50% of air volume ventilates the thorax while the remainder circulates through the abdominal region. When the total air circulation at different temperatures was compared with oxygen consumption it has been noticed that the air intake increases disproportionately more than the expected values. Amount of air intake through the spiracles/min. also continues to increase disproportionately more with increase in temperature even though O_2 consumption falls after 38°C. The observed values of air intake during rise in successive temperatures are much more than the expected values of air intake. This forced air convection through the tracheal system of various heat generating body compartments brings about thermal homeostasis. It has been hypothesised that diffusion of air of a given constitution at any temperature is brought about by temperature dependent respiratory stimulations and it also introduces several times greater quantity of air to buffer the lethal effects of higher temperatures. It is suggested that the entire respiratory apparatus is designed to regulate thermal stress in which the excess air acts as a coolant very much like an " Air cooled engine " in which forced convection is utilised for heat exchange.

3P,2

TIME MEASURING MECHANISM OF EGG HATCHING IN METRIOPTERA HIME (ORTHOPTERA: TETTIGONIDAE). Arai, T. (Lab. Entomol., Hirosaki Univ., Hirosaki, 036 Japan)

It was suggested from observations of hatching pattern in M. hime in various cycles, steps, and pulses of light and temperature that a time measuring system was involved and that it was set in motion by signals of light-on, light-off, temperature rise, or temperature fall. The characteristics of this timing reaction are as follows: (1) any circadian rhythm of hatching was not observed; (2) the time-measuring reaction was triggered by a single stimulus of light-off or temperature fall; (3) the effect of light-on or temperature rise changed with the laspe of time after the system was set in motion by light-off or temperature fall; (4) the process of thermoperiodic time measurement was effected by light conditions; (5) the time measurement was compensated for temperature; and (6) the hatching behavior was directly triggered by a single stimulus of light-on or temperature rise. A model will be proposed to account for the responses to photoperiodic and thermoperiodic time cues.

3P,3

NON SPECIFIC EFFECTS OF STERILIZING AGENTS (CHEMICAL OR PHYSICAL) ON MUSCA DOMESTICA L. (DIPTERA MUSCIDAE). ECHAUBARD Michel and LE BRAS Suzette.

The sterilizing agents used in insect populations control produce general perturbations of physiology, non specific of these searching for insects sterilizing.

Alterations of proteidic and glucidic metabolisms, independants from the arrest of ovarian development, were found after the action of Hempa or X rays.

These metabolic modifications are associated, on the one hand with a direct effect of these sterilizing agents on enzymatic activity, on the other hand with an indirect effect by intermediate of the alterration of neuro-endocrine control of metabolism and particurlary alterrations of Corpora allata.

3P,4 PHOTOPERIODIC SENSITIVITY AND FAT BODY DEVELOPMENT THROUGH THE PREDIAPAUSE PERIOD IN THE HENOSEPILACHNA BEETLE.

Kono, Y. (Pesticide Res. Lab., Takeda Chemical Industries Ltd., Ichijoji, Sakyo-ku, Kyoto, 606 Japan)

The body weight of the Henosepilachna adult reared on the foliage under the short-day photoperiod increased markedly to be over 150% at the 6th day of adult life (100% at the emergence), and the fat body developed simultaneously to filled the body cavity until the 16th day, when the beetles ceased to feed and entered diapause.
NSC in the brain - CA system in these insects became insensitive to the long day later than 5th day, and consequently, the ovary did not develop even if the photoperiod changed from a short day to a long day.
When the adults were fed on sliced potato or on reduced amount of the foliage, the sensitivity to the photoperiodic change was retained longer. The analysis of the relationship between the body weight and the response to the photoperiodic change gave a conclusion that the sensitivity was lost in the course of the fat body development.

3P,5 ADJUSTMENT OF ACTIVITY RHYTHMS IN INSECTS TO THE ENVIRONMENTAL CONDITIONS

Tshernyshev W.B.. and Zotov V.A. (Dept.Ent.,Moscow State University,117234 USSR)

The time-schedule of insect activity depends on both the endogenous rhythm and the environmental conditions.The transitions from activity to rest and vice versa may be earlier or later but only in the course of certain time intervals.We call these intervals as the Time of Potential Readiness (TPR)(Tshernyshev,1973,1978).The sensitivity of organism to signal factors increases during TPR.The artificial illumination and heating permit to measure durations of the TPRś and to determine the ruling factors (Zotov,1980).In nature the desert beetles Trigonoscelis gigas Rtt. are active only in the morning and in the evening.Hence there are 4 TPRś in their rhythm.The duration of these TPRś ranges from 2 to 0.5 hrs.For the 3 TPRś the signal factor is the temperature,for the last evening TPR such factor is the light. In the middle of day and at night the artificial changes of conditions can not provoke the activity of these beetles.Under the constant conditions in experiments the rhythm is changed due to the phase shifts for every TPR.

3P,6 CIRCADIAN PHOTORECEPTORS OF THE HOUSEFLY *MUSCA DOMESTICA*

Gunning, R. V. (N.S.W. Department of Agriculture, Australia)

Results of ocelli and compound eye opaquing experiments indicated that the housefly eye nerve activity rhythm (Gunning and Shipp, 1976) was entrained via the ocelli. The nature of the rhythm in ocelli opaqued flies resembled that of the rhythm in constant dark.

3P,7

RESPONSES OF THE MECHANOSENSORY NEURON OF THE CRICKET(*TELEOGRYLLUS EMMA*) TO WIND PUFFS. Ai,N., Yamaguchi, N. and Hiramura, K.(Dept.Biol.,Tokyo Gakugei Univ., Tokyo, I84 Japan)

A puff of air directed to the fore-leg tibial sensory hairs of a cricket evoked an orientation behavior under certain conditions. This response is an orientation towards the source of wind.To investigate such responses,afferent nerve impulses were recorded extracellularly on the 5th lateral root derived from the prothoracic ganglion. These impulses were integrated in the prothoracic ganglion and then descended bilaterally from the pro-mesothoracic ganglion connective.However,conduction delay in the contralateral connective on the transmission of induced impulses were sometimes longer than that in the ipsilateral one.This neural activity shows that the conduction pathway of the motor signal in the prothoracic ganglion should have be modified by several interneurons or neural elements.

3P,8

ORDER-SPECIFIC, SPECIES-SPECIFIC AND STADIUM-SPECIFIC ELEMENTS IN THE NEUROSECRETORY SYSTEM OF THE MEDIAN PROTOCEREBRUM OF LEPIDOPTERA.

Panov A.A. (Inst. Evol. Anim. Morphol. Ecol., Acad. Sci. USSR, Moscow, USSR).

In more than 50 species of Lepidoptera belonging to I3 families, 3 categories of neurosecretory cells (NSCs) are revealed in the median protocerebrum. As order-specific NSCs are considered A'- and A"- cells of the group MI and NSCs of the group M2 and M3 found in all species studied. Their number appears to be constant within the order (4,4,2 and 2 cells in each hemisphere, resp.). In the oxidized state, the neurosecretory material (NSM7 of A'- cells is rich in strong acid groups reacting with AB or PF even at pH 0.2-I.0. The NSM of both A"- and M3-cells is mostly rich in weak acid groups binding AB or PF only at pH 2.5 or higher. The NSM of M2-cells contains both strong and weak acid groups in the oxidized state. B_1-, B_s- and A2'c cells (i,2 and 2 cells generally in each hemisphere, resp.) as well as some other NSC types are considered as species-specific NACs. These cells occur only in a part of species studied. B_1- and B_s- cells are mostly phloxinophil, and the NSM of A2'- cells stains pinkish-purple with PF only at pH 2.5. Numerous B_i- NSCs are considered as stadiumspecific ones. They occur in adult brains only. M3- cells appear to be also stadiumspecific as they are distinctly visible in larvae and generally can not be revealed in adults.

3P,9

STEREOSPECIFICITY OF MULTIPLE RECEPTOR SITE IN A LABELLAR SUGAR RECEPTOR OF THE FLESHFLY FOR AMINO ACIDS AND SMALL PEPTIDES. Shimada, I. and Tanimura, T. (Dept. Biol. Sci., Tohoku Univ., Kawauchi, Sendai 980, Japan)

At least three different sites (P, F and T) are well documented in the sugar receptor of the fleshfly. Four aliphatic amino acids (valine, leucine, isoleucine, and methionine) were determined to react with the T site. Two aromatic amino acids (phenylalanine and tryptophan) reacted with the F site. The results of various modification of the functional group of stimulants lead to a substantial difference in the stereospecificity between the two sites. The effect of small peptides on the sugar receptor was examined systematically. This effect depends mainly on the place of the constituent amino acids rather than on the composition, which exactly corresponds to the different stereospecificity of each receptor site. Two hypothetical models of the F and T sites have been proposed which involve three and two subsites, respectively, that are capable of hydrogen bond formation. They further have a hydrophobic subsite together with a few spatial barriers that can discriminate the R groups of each stimulant.

3P,11 REGULARITIES OF THE FATTY ACID COMPONENTS IN THE CARABID DEFENSIVE SECRETIONS IN RELATION TO PRECURSORS.

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Pygidial defensive systems were present in all carabid beetles. Components so far detected were divided into six groups,1) formic acid,2) methacrylic and tiglic acids, 3) the 2) plus crotonic, angelic and a few fatty acids,4) metacresol,5) quinones with one chamber,6) quinones with two chambers. These groups were associated with morphology of the synthetic lobes, spherical lobes produced fatty acids, elongate lobes produced metacresol and long and thick lobes produced quinones. It was considered to be regularities, even though there were differences in number and amounts of fatty acids among species. The regularities were resulted from restricted precursors, branched amino acids, i. e. valine, isoleucine and leucine. Main components detected in the secretions may be stored in the reservoir chambers at the specific intermedial stages in the metabolic course.

3P,12 (Z)-5,(E)-7-Dodecadien-1-ol : Sex Pheromone of the Pine Moth[1]

N. Takahashi, M. H. Vu, T. Ando, S. Yoshida, S. Tatsuki*, K. Katagiri**, A. Yamane**, T. Ikeda** and S. Yamazaki** (Dept. of Agric. Chem., The University of Tokyo, Tokyo, 113 Japan, * The Institute of Physical and Chemical Research, Saitama, 315 Japan, ** Forestry and Forest Products Research Institute, P. O. Box 2, Ushiku, Ibaraki, 300-12 Japan)

The pheromone of pine moth, *Dendrolimus spectabilis* Butler (Lepidoptera : Lasiocampidae), which is a harmful defoliator of the pine tree in Eastern Asia countries, was elucidated by efficient use of electroantennogram (EAG) technique without the mass-rearing of the insects. By the EAG analyses of fractions obtained by TLC and GC (OV-1 and PEG 20M columns) fractionation of the virgin female extract, the pheromone was shown to be 12-carbon diene alcohol. EAG assay for a series of monoene alcohols suggested that the pheromone alcohol possessed the unsaturation at C_5 and C_7. All four isomers of 5,7-dodecadien-1-ol were synthesized stereo-selectively *via* acetylenic compounds, and in a preliminary field trial with those synthetic candidates only the traps baited with (Z)-5,(E)-7-isomer could catch appreciable number of male moths. In analyses by GC and GC-MS, the presence of (Z)-5,(E)-7-isomer in the female extract was confirmed. Thus, it is concluded that the female sex pheromone of the pine moth is (Z)-5,(E)-7-dodecadien-1-ol. In addition to this isomer, the presence of a minor amount of (E)-5,(E)-7-isomer was also revealed. The experiments to clarify the role of the (E)-5,(E)-7-isomer on the seriated sexal behavior, particularly examination of the synergistic effect of this isomer in the field attraction, are in progress.

[1] Agric. Biol. Chem., **43**, 1615 (1979), **44**, 231 (1980).

3P,13 THE OVIPOSITION-STIMULATING SUBSTANCE IN *BOMBYX MORI*.

YAMAOKA, K., MORIYAMA, H., SHIGEMATSU, H. and ARAI, N. (Natural Science Lab., Toyo Univ., Bunkyo-ku, Tokyo 112, Japan)

The virginal egg-laying is activated by injection of the aqueous extract of the male reproductive tract (OSS) into the haemocoel. The spontaneous motor activity of the female last abdominal ganglion (G Ⅸ) is enhanced by the application of OSS into the solution in which isolated ganglion preparation was immersed. We tried to purify OSS. To measure the specific activity of OSS samples the dose-response curve on the egg-laying test was established. Although we had not succeeded to isolate OSS yet, the partial purification was carried out by the combination of Sephadex gel filteration and ion exchange chromatography, and an OSS fraction reached ca. 1500 times in its specific activity. The effect of OSS on the female reproductive tract was electrophysiologically studied. The *in situ* vestibulum preparation was connected to CNS by a nerve bundle N 2 of G Ⅸ. Spike and plateau potentials were recorded from the vestibular muscle system. The spike was PSP, and the plateau appeared the action potential. OSS increased PSP frequency and slowed the spike repolarization, often resulting in the triggering of the plateaus. The plateau was associated with a slow, large single contraction of the vestibulum, which contributed to the pressing-out movement of the eggs. OSS may be involved in egg-deposition in this manner.

3P,14

OXIDATIVE DEGRADATION OF ALDEHYDIC PHEROMONES: LABORATORY AND FIELD STUDIES.

Weatherston, J., Carlson, P.W., Golub, M.A., Phelan, S.A. and Lee, J.M. (Conrel, 110 A St., Needham Heights, MA 02194 U.S.A.)

The efficacy of pheromones used for the control of pest species by mating disruption depends in part on their field longevity. The labile nature of unsaturated aldehydes makes them very susceptible to oxidative degradation. Such degradation of pheromonal aldehydes has been studied in the laboratory and under field conditions. The nature of the products, and their relationship to the effective life of the formulation have been determined.

The contributing influence of oxygen and U.V. light will be discussed together with the consequences of employing antioxidants and U.V. screens.

3P,15

ECDYSTEROID TITRE, ACID PHOSPHATASE ACTIVITY IN THE FAT BODY AND DIAPAUSE PROTEINS IN RELATION TO DIAPAUSE INDUCTION IN THE COLORADO POTATO BEETLE. De Loof, A., Briers, T., Peferoen, M., Salem H. and Stoppie, P. (University of Louvain, Zool. Inst., Louvain, Belgium)

Ecdysteroid titres were measured during metamorphosis, in reproducing animals (Long day (LD):16 h photophase, 25°C) and in prediapausing and diapausing (Short day (SD):10 h photophase, 25°C) Leptinotarsa decemlineata by radioimmunoassay. In 4-5 SD animals of both sexes, a titre of ± 95 ng/g was found while in reproducing animals of the same age the titre was only ± 50 ng/g in males and ± 24 ng/g in females. The 95 ng/g titre in SD animals coincided with the appearance of typical diapause proteins (DP 1, DP 2, DP 3) in the haemolymph and of acid phosphatase activity in the fat body. Study of the ultrastructure of the fat body revealed that protein granules in this tissue seem to originate from lysosomes. Monospecific antisera were prepared against the 3 diapauseproteins of the haemolymph. DP 1 was found to be immunologically different from DP 2 and DP 3. DP 2 and DP 3 were identical.

3P,16

PROTEIN CHANGES IN THE HAEMOLYMPH AND FAT BODY OF PIERIS RAPAE L. DURING THE CUTICLE FORMATION AND HARDENING. Kim, H.R. and Kim, C.W. (Dept. Biol., Korea Univ., Seoul 132, Korea)

The origin and pattern of haemolymph protein during the cuticle formation and hardening are determined by means of acrylamide gel electrophoresis and immuno diffusion. Total 19 bands are obtained in the haemolymph during the early pupal stage, of which 9 bands appeared constantly throughout the whole period, and bands 10 and 14 are at high concentration over the whole period while band 15 gradually decreased with time and bands 16 to 19 showed variety of changes. In the fat body, however, total 13 bands are detected, all of them showed no drastic changes. Findings by immuno diffusion showed a clear identity between proteins of haemolymph and fat body during short period after pupation, suggesting that some proteins are synthesized in the fat body and then transported into the haemolymph.

3P,17 NCA I AND II AND THE REGULATION OF CORPUS ALLATUM ACTIVITY IN ADULT FEMALES OF THE COCKROACH, BYRSOTRIA FUMIGATA.

Barth, R.H. and Rachman, N.J. (Dept. Zool., Univ. TX, Austin,TX.78712,U.S.A.)

Cyclical reproduction in Byrsotria fumigata is due to fluctuations in corpus allatum (CA) activity. These fluctuations in turn depend on the nervous connections of the CA, as previous studies have shown that isolated glands are not responsive to external stimuli and though they may shown cyclical histological and secretory changes, these are not coordinated to produce normal reproductive cycles. Here we report on an investigation of the respective roles in the coordination of reproduction of the two major nerves linking the CA to the central nervous system. Using methylene blue stained preparations we have elucidated the gross anatomy of the connections of the NCAI to the brain and the NCAII to the subesophageal ganglion. Use of the cobalt chloride backfilling technique has permitted a more detailed analysis of the connections of the NCAI within the brain. The effect of surgical interruption of each nerve will be discussed in relation to the following phenomena: 1)the reactivation of the CA after the adult molt; 2) the enhancement of egg development (or the prevention of yolk resorption) after mating; 3) the suppression of the CA during pregnancy. For each experimental manipulation 3 functions are measured as indicative of CA activity: oocyte growth through yolk deposition, sex pheromone production and colleterial gland secretion. These are correlated with the relative level of juvenile hormone (JH) in the blood of experimental females as determined by the Manduca larval pigmentation bioassay. Severance of the NCAI within the first 8 hours after the adult molt prevents reactivation of the CA. This nerve also seems to mediate the promotion of oocyte growth resulting from mating. NCAII seems not to be involved in either of these phenomena. The effect of severance of one or the other of these nerves in pregnant females is currently under investigation.

3P,18 OVARIAN DEVELOPMENT AND EMBRYOGENESIS IN VITELLOGENIN-DEFICIENT EGGS FROM MALE HOSTS OF SILKWORMS.

YAMASHITA,O., IRIE,K. and OHTSUKI,Y.(Fac. Agric. Nagoya Univ. Nagoya, Seric. Exp. Sta. Tsukuba, Japan)

We examined whether eggs matured in male hosts of silkworms, if activated by artificial parthenogenesis, can complete embryonic and post-embryonic development. The rudimentary ovaries transplanted into male larvae developed mature eggs with chorion at adult emergence. The eggs contained much glycogen and less protein. A polyacrylamide gel electrophoresis demonstrated that vitellogenin was lacking. Histochemical observations showed that the yolk granules have developed well but Vg is deficient. When activated by an artificial parthenogenesis, matured eggs started their embryogenesis, and further embryonic development progressed , and larvae hatched. The larvae grew successfully and reached maturing to spin cocoons.

3P,19 STUDIES ON THE BIOCEMICAL AND GENETIC PROPERTIES OF THE KIUKI MUTANT OF THE SILKWORM, BOMBYX MORI.

Tsusué, M., Mazda, T. (Biol. Lab., Kitasato Univ., Sagamihara, Kanagawa, 228 Japan) and Sakate, S. (Sericult. Expe. Stat., Yatabe, Ibaraki, 305 Japan)

A natural mutant Kiuki of silkworm has yellow pigment in its integument. The yellow hue of the mutant is rather pale than that of lemon mutant. A yellow pteridine characteristic of the mutant was isolated from the integument. Based on instrumental analysis, the pigment was identified as sepialumazine. Cross experiment of the mutant with normal type silkworm clearfied that the mutant was not completely dominant. The amounts of the pigment accumulated in the integument depended on sepiapterin deaminase. The gene affected the enzyme activity additively. We will designate the Kiuki mutant by the symbol Sel.

3P,20

ORGAN SPECIFIC RESPONSE TO JUVENOID IN THE METABOLISM OF THE SILKWORM.

Shigematsu, H. (Sericul. Exp. Sta., Ibaragi-ken, 305 Japan)

We investigated an alteration of the functions of silk gland, fat body and haemolymph. Juvenoid was applied to the silkworm in the earlier stage of the fifth instar. Although the hormone treatment elongated the progress of the larval development, resulting in the body weight, there was no difference in the growing rate between the experimental and the control groups. The cocoon in question was heavier than the control, while its silk layer was not. By the juvenoid treatment the silk gland stopped growing temporarily, but the fat body kept up its growing rate as same as in the control. At first, juvenoid impeded the increase of quantity of nucleic acids and silk protein in the posterior silk gland. The fat body did not show such an alteration and maintained the synthesis of DNA and of protein. An application of juvenoid to larva caused an elevation of protein concentration in haemolymph. The total concentration of free amino acids in haemolymph increased quickly just after the treatment of juvenoid on the 2nd and 3rd days of the fifth instar. The juvenoid treatment caused a rapid fall of tyrosine concentration in haemolymph, and then raised it, being far ahead of the control.

3P,21

VITELLOGENIN MESSENGER RNA SYNTHESIS STIMULATED BY JUVENILE HORMONE ANALOG IN THE LOCUST.

Chinzei, Y., Potter, R.J., White, B.N., and Wyatt, G.R. (Dept. Biol., Queen's Univ., Kingston, Ont. K7L 3N6, Canada)

Synthesis of vitellogenin (yolk precursor protein, VG) in fat body of adult female *Locusta migratoria* depends on stimulation by juvenile hormone (JH), which appears to act at the nuclear level (Chen *et al.*, Dev. Biol. 69, 59, 1979; Couble *et al.*, J. Insect Physiol. 25, 327, 1979). We have studied changes in RNA in this tissue. Total RNA from mature female fat body, when analyzed by denaturing agarose gel electrophoresis, shows a band at 32 S (7000 nucleotides) which is lacking in RNA from males or immature females. This component has been concentrated by binding to oligo-dT-cellulose and sucrose gradient centrifugation and identified as VG mRNA by translation in a cell-free system. VG mRNA has been assayed by photometric scanning of stained gels of total fat body RNA. Hormonal induction has been followed in locusts in which the corpora allata were destroyed by treatment with 6-methoxy-7-ethoxy-2,2-dimethyl chromene ("Precocene III"). In primary induction of VG synthesis, by injection of 150 µg of the JH analog ZR-515, VG mRNA was first detectable at 48 hours and accumulated at an initial rate of 0.2 µg/fat body/day, rising after 4 days to 1 µg/day. In induction by a second dose of ZR-515 after decline of the primary response, VG mRNA was detected at 24 hours and accumulated at about 2 µg/fat body/day. Total (chiefly ribosomal) RNA, on the other hand, accumulated markedly during primary induction and only slightly during secondary induction; this is reflected in strong stimulation of ^{3}H-uridine incorporation into bulk RNA during primary induction and little stimulation in secondary induction. We conclude that the action of juvenile hormone on this tissue involves a selective stimulation of transcription of VG genes. In the primary response this is accompanied by synthesis of ribosomal RNA and other components of the protein-synthetic apparatus. After initial exposure, however, the cells are altered so that the specific mRNA response is enhanced and the non-specific response diminished. (Supported by Canada NSERC and US NIH.)

3P,22

EFFECT OF JUVENILE HORMONE ANALOGUE ON SYNTHESIS OF NUCLEIC ACIDS IN THE POSTERIOR SILK GLAND OF THE SILKWORM, *BOMBYX MORI*.

Kurata, K. (Sericul. Exp. Sta. Ibaragi, 306 Japan)

The effect of application time of juvenile hormone analogue dissolved (JH-acetone) in acetone solution on the synthesis of nucleic acids in the posterior silk gland was studied in the 5th instar larvae of the silkworm. Similar results were obtained in both synthesis of DNA and RNA in the silk gland. The rate of DNA accumulation showed a lag phase after an application of JH-acetone durring the first 4 days of the 5th instar, the DNA content reached finally the level of the control. In some cases, the quantity of DNA accumulation was founed to be nearly twofold as compared with that of the control. The accumulation of RNA in the treated larvae was 150 % of that in the control, at the 2 or 3 days before maturation. JH-acetone temporalily diminished the thymidine kinase activity and ^{3}H-thymidine incorporation rate, but thereafter resulted in an additional increase of the activity and of the incorporation rate as compared with the control. By the JH-acetone administration after the 5th day, however, there was no evidence of the increase of the DNA content and of the thymidine kinase activity, in the same manner as those of the control. But ^{3}H-uridine incorporation into the RNA increased at 9th or 10th day of the 5th instar.

3P,23 Initiation of Fibroin Biosynthesis in Bombyx mori.

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(Dept. Agr. Chem., Tohoku Univ. Sendai, 980 Japan)

To inquire the initiation processes in fibroin biosynthesis, nascent peptides were isolated from the posterior silk gland ribosomes of Bombyx mori, fractionated by gel chromatography into twelve fractions and assayed for amino acid composition.

The nascent peptides of smaller-molecular size exhibited an amino acid composition quite different from that of fibroin, especially rich in glutamic and aspartic acids. However, the amino acid composition of the nascent peptides of larger-molecular size approached gradually to that of fibroin as their molecular sizes increased. The nascent peptide fraction having a molecular weight of 20,000∼25,000 was compared with fibroin small subunit (M.W. 25,000) by amino acid analysis, tryptic peptide mapping and N-terminal amino acid sequencing. All the data obtained indicated a similarity between the two proteins. Thus, we propose a working hypothesis that the nascent peptides in fibroin synthesis comprise an acidic peptide portion at the N-terminal region and a "fibroin-type" peptide portion at the C-terminal region, and that the N-terminal portion serves as a precursor of fibroin small subunit.

3P,24 THE INVESTIGATION OF PYRIMIDINIC OLYGONUCLEOTIDES OF INSECT DNA

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DNA was isolated from last instar larvae of different species of insects by Marmure procedure.The isolated DNA was treated by diphenylamine in formic acid for pyrimidinic olygonucleotides preparation.The olygonucleotides were separated by DEAE-32-cellulose on blocks contained from 2 to 10 nucleotide residues.The content of the olygonucleotides was determined.The differences in amounts of large and short pyrimidine blocks between Bombyx mori,Antheraea pernyi,Limantria dispar,Phalera bucephala,Hyphantria cunea,Blaberus gigantens,Gramphadarina partentosa,and Periplaneta americana were discussed.

3P,25 DEGRADATION OF INSECT AND SYNTHETIC MELANINS BY ASPERGILLUS FUMIGATUS.

J.P. Luther and H. Lipke, (Biology Dept., Univ. of Massachusetts/Boston, Dorchester, MA 02125).

Melanin, Melanoprotein and sclerotized protein resist microbial action due to stable aryl bonds linking phenolic and indolic residues. Whereas soil microflora utilize unconjugated chitin or protein completely within a few days, recycling of pigmented tanned cuticle has been problematic since 95% of the melanin exposed to soils can be recovered after 50-100 days (Gray & Baxby, Trans. Br. Myc. Soc. 51:293; Bloomfield & Alexander, J. Bact. 93:1276; Martin & Haider, Appl. Envir. Microbiol. 38:283). A strain of A. fumigatus has now been isolated from composted coffee and garden wastes that utilizes two insect melanins as a sole source of carbon as well as pigments from octopus ink, hair, banana, polymerized tyrosine and dopa. With a sucrose supplement, degradation was complete after 50 days at 30C in Czapek medium at pH6. The catabolic rate differed for each substrate pigment as did the molecular weight of the products. Following incubation with labelled melanin, 50% of the isotope was recovered from a newly formed dark pigment deposited in the mycelia, the remainder was incorporated into cell protein, lipid, chitin, CO_2 and polar metabolites. The fungal pigment induced by the substrate melanin differed in uv-, ir- and chemical composition from the melanin offered the organism. Deposition of pigment in the mycleia grown on melanin increased the resistance of the cell wall to cellulase and chitinase, suggesting that the acquisition of pigment by the fungi may assist in the formation of soil humus which is composed of digested lignins and colored residues from decayed animals and microorganisms.

3P,26

EFFECT OF GROWTH REGULATORS ON THE ACTIVITY OF SOME ENZYMES OF MUSCA DOMESTICA L., TENEBRIO MOLITOR L., AND BOMBYX MORI L.

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Effect of different inhibitors of chitin synthesis (diflubenzuron TH-6040 and its II analogues) on the activity of esterases, glucose-6-phosphate dehydrogenase, trehalase, hexokinase, and chitinase was studied in larvae of Musca domestica L.; the action of some juvenile hormone analogues (altosid, "Manta", and other insect growth regulators) on the activity of the enzymes was tested in homogenates of pupae Tenebrio molitor L., and various larvae tissues Bombyx mori L. The effect of injections of α-ecdysone on the esterases and acid phosphotase activity in larvae Musca domestica L. and Bombyx mori L. was also studied. Number of multiple forms of enzymes and their activity was changed by influence of effectors enumerated above.

3P,27

QUANTITATIVE STUDY IN UTILIZATION OF NITROGEN AND AMINO ACIDS BY THE SILKWORM,(BOMBYX MORI)

Horie, Y. and Watanabe, K. (Sericult. Exp. Sta., Ibaraki 305, Japan)

The quantitative requirement and utilization of nitrogen compounds including amino acids by the silkworm were determined in this work, and special emphasis is placed on stoichiometrical elucidation in economy of these substances throughout the life-cycle of the individual silkworm. The amounts of nitrogen ingested by a single male and female during larval stage were 12 and 14 mmoles and 63% of them was absorbed. Almost all of nitrogen absorbed was accumulated in the mature larva and the cocoon; 7.2 and 9.2 mmoles of nitrogen for male and female, respectively. The recovery of absorbed nitrogen in cocoon layer was 70 and 66% for male and female, respectively. The amino acid balance between the amounts absorbed and those stored in the cocoon are calculated in mole units of amino nitrogen. The total decrease of decreasing group of amino acid was approximately equal to the total increase of increasing group of amino acid, and the former group consists of the essential amino acids, whereas the latter consists of the four amino acids; main components of fibroin. By using ^{14}C- and ^{15}N-amino acids, the distributions of ^{14}C and ^{15}N of amino acids were estimated in pupa, cocoon layer and CO_2 expired. These distribution and the recovery in various parts were greatly dependent on kinds of amino acid and stages ingested.

3P,28

γ-Glutamyltransferase in organism of silkworm (Bombyx mori L.).

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Gorlenko V.A.

While researching the ways of biosynthesis of γ-glutanyl peptides in silkworm (Bombyx mori L.), the γ-glutamyltransferase (GGTP) was found in the whole insect and its several tissues. GGTP proved to take part in sclerotization process possibly by its transportation of phenylalanine and tyrosine into cuticle's cells. The ontogenical behaviour of GGTP was studied and connection between the enzyme action and such process as the appearance of the new tissues, moulting and reproduction was found. The study of the GGTP specificity in regard to amino acids and peptides as acceptors of γ-glutamyl residue disclosed the deep differences between silkworm's and mammalians' GGTP. Unlike mammalians' GGTP enzyme of silkworm is likely to exist in some molecular forms located in functionally different tissues.

3P,29

PROTEIN KINASE IN THE OVARY OF THE SILKWORM, BOMBYX MORI : PURIFICATION, CHARACTERIZATION AND ITS ENDOGENEOUS PROTEIN SUBSTRATES. Takahashi, Y.S. (Biological Inst., Facul. Sci., Nagoya Univ., Nagoya 464, Japan)

In our previous paper, developing silkworm eggs contein two cyclic nucleotide-dependent protein kinases, namely, guanosine 3',5'-monophosphate-dependent and adenosine 3',5'-monophosphate-dependent protein kinase. These two kinases showed different changes in their activities during the course of development. This suggests that they play different roles in the development of the silkworm eggs.

In the course of the survey of their endogeneous substrates in the eggs, the author found the protein kinase which have low dependency for cyclic nucleotides in the ovary of the silkworm, Bombyx mori. The kinase was extractable from the ovary by high salt concentration and purified using acid precipitation, DEAE-cellulose chromatography, ammonium sulphate fractionation and gel filtration techniques.

The endogeneous substrates were also detected and partially characterized.

Roles of phosphorylated substrates in the ovary and developing eggs were discussed in relation to protein kinase activity.

3P,30

GUANYLATE CYCLASE IN SILKWORM FAT BODY. Morishima, I. (Dept. Agric. Chem. Tottori Univ., Tottori, 680 Japan)

Homogenate of silkworm (Bombyx mori) pupal fat body contained relatively high activity of guanylate cyclase compared to adenylate cyclase. More than 90% of the guanylate cyclase activity was present in particulate fraction, essentially no soluble activity being detected. Approx. 50% of the activity present in particulate fraction could be solubilized with Triton X100. The activity was dependent on Mn^{2+} but not on Mg^{2+}, Ca^{2+} or Ba^{2+}, and activated approx. 3-fold by non-ionic detergent such as Triton X100 or Lubrol PX. In the presence of a fixed free Mn^{2+} concentration, variation in MnGTP resulted in double-reciprocal plots of a concave-upward nature. The Hill coefficient was 1.5 and $S_{0.5}$ was 80μM. These positive cooperative patterns were observed in the presence or absence of Triton X100. The activity was not activated by NaN_3 unlike guanylate cyclase of rat tissues. Changes of guanylate cyclase activity during larval-pupal development will also be presented together with the changes of the adenylate cyclase activity.

3P,31

SEXUAL DIFFERENCES IN UTILIZATION AND METABOLISM OF SULFUR AMINO ACIDS IN THE SILKWORM, BOMBYX MORI Shinbo,H (Sericult. Exp. Sta., Tsukuba, Ibaraki 305, Japan)

The utilization and metabolism of sulfur amino acids in the silkworm were investigared. The amounts of sulfur ingested by a single larva growing of mulberry leaves were 9.5 and 10.6mg for male and female during the 5th instar, and 25 and 40% of sulfur ingested were stored in the mature male larva and female larva, respectively. In the female, a large amount of sulfur stored in the pupal body was used for egg formation, especially for egg shell formation during pupal stage. Furthermore, the nutritional study using the amino-acid diet showed that the female larvae required more sulfur amino acids than males for the growth. These results indicate that there is a significant sexual difference in the quantitative requirement and utilization of sulfur amino acids in the silkworm. The rate of degradation of sulfur amino acids in pupae was more active in male than in female; that is, a higher recovery of radioactivity in CO_2 after injection of ^{14}C-cystine was obtained in male than in female. It was also found that the activities of both cystathionine synthetase and cystathinase of larval fat body varied according to the growth, and that they were significantly higher in the male than in the female.

3P,33 THE INFLUENCE OF PHYSIOLOGICAL CONDITION OF THE HOST ON THE DEVELOPMENT OF THE PARASITOID (*TROGUS MACTATOR*).

Omata,k. (Fac. Agr., Tokyo Univ., Tokyo, Japan)

The observations of the development of parasitoids (*Trogus mactator*) revealed that the first instar larvae didn't develop to second instar until their hosts (*Papilio xuthus*) pupated. To clarify which physiological condition of the host effects on the development of its parasitoid, following experiments were carried. The parasitized fifth instar larva was ligatured, and the developmental manner of the parasitoid was examined. When the abdomen of the ligatured host pupated, the parasitoid developed to the second instar, but didn't if it remained a larva. Likewise the host was exposed to the photoperiod of 15 hours per day after pupation, the parasitoid developed to the second instar even if host pupa was diapausing. Subsequently the first instar larva of the parasitoid was taken from its host was reared in MGM-431 medium containing β-ecdyson, the formation of new integment was observed after two weeks at 25 c. From these results, the process to pupation of host seemed to be an important factor for the development of the parasitoid.

3P,34 *IN VITRO* ANALYSES OF THE ROLE OF HEMOLYMPH IN THE INITIAL CELLULAR ATTACHMENT TO FOREIGN CELLS IN THE SILKWORM, *Bombyx mori*.

WAGO,H.(Dept.Bacteriol., Saitama Medical Coll.,Saitama,350-04 Japan)

The effect of hemolympn of the silkworm, *Bombyx mori*, on the frequency of foreignness-binding hemocytes was studied with the scanning scanning electron microscopy (SEM), using a rosette assay with goose erythrocytes (GRBC). Hemocytes were shown to be able to bind to GRBC in the absence of hemolymph. Hemocyte type involved in the spontaneous rosettes was mainly the granular cell,while both plasmatocytes and the prohemocytes were also observed to adhere to GRBC,although the frequency of GRBC-binding cells was low. On the other hand, observations by the SEM showed that the addition of hemolymph to the incubation media increased the number of GRBC-binding hemocytes, especially that of the granular cells and plasmatocytes. Therefore, it seemed that the hemolymph had a significant role in promoting the attachment of the granular cells and plasmatocytes to foreignness.

3P,35 ATP PHOTOPRODUCTION IN INSECT INTEGUMENT : STUDY OF THE CELLULAR MECHANISM

Vuillaume M. and Best-Belpomme M. (Zool. Lab. E.N.S. 75230 Paris France).

Cell-free extracts of *Pieris brassicae* integument exhibit a light-dependent-ATP production system (LAPS). It remains in a 220,000 x g supernatant previously sonicated . The substrates of the photodependent reaction seems to be ADP and P_i.
These results suggest that LAPS cannot located in intact mitochondria.
We discuss the biochemical and electrochemical results and propose a new mechanism of ATP photophosphorylation.

Section 4.

Ecology and Population Dynamics.

4S-1,1 ROLE OF ENVIRONMENTAL CUES IN THE SEASONALITY OF REPRODUCTION IN INSECTS DIAPAUSING AS ADULTS.

Hodek I. (Inst. Ent., Czechosl. Acad. Sci., Prague 12800, Czechoslovakia).

Some aspects of the regulation of reproduction have been neglected.

(1) Some insects overwinter more than once : to re-enter diapause they need to be again able to respond to photoperiod. This is allowed by the recurrent photoperiodic response which has been found in a Heteropteran, an Orthopteran and recently also in a proportion of the Czech population of Coccinella septempunctata. Recurrent photoperiodic response is lacking in another coccinellid, Semiadalia undecimnotata ; its regulative function may be, however, presumed in other described cases of adult diapause (eg. in some other Coleoptera).

(2) The recent chaos in types and definitions of diapause is due to the under- or overestimation of one of two prerequisites for the resumption of development : passage of time and stimulation. These two processes (horotely, tachytely) leading to the same goal are mutually complementary to a great extent. This causes the eurytelic nature of diapause. The possibility of choice among several pathways increases the adaptive value of diapause.

4S-1,2 MIGRATION AND ADULT DIAPAUSE IN NOCTUID MOTHS WITH SPECIAL REFERENCE TO AESTIVATION.

Oku, T. (Tohoku Nat. Agr. Exp. Sta., Morioka, 020-01 Japan)

In the temperate zone, some noctuids pass the hot season in an adult diapause. During the aestivation period, the nocturnal activity is usually lowered, and the females are kept sexually immature under the influence of long day. The shortened day-length in autumn reactivates the dormant adults and stimulates the ovarian development. The overwintering stage varies from species to species, and it functions to sychronize the larval development to the seasonal growth of food-plants. Forest inhabitants such as Amphipyra stay in their breeding grounds in lowlands, and aestivate in buildings, dead trees, etc. On the other hand, a special migration habit is often encountered in so-called cutworms, Euxoa, Agrotis, etc., which prefer drier open places for breeding. The migrants leave the breeding grounds soon after the emergence, and pass the diapause period under stones or in caves above the timber-line. Within the same species, the migration habit is more pronounced in the southern pupulations. The migration may have evolved to avoid the hot and dry summer in the breeding grounds.

4S-1,3 THE REVERSIBILITY AND FLEXIBILITY OF THE REPRODUCTIVE DIAPAUSE IN MALES OF A "SHORT-DAY" GRASSHOPPER, OEDIPODA MINIATA; A MODEL OF A PRIMITIVE DIAPAUSE WITH POSSIBLE ADAPTATIVE ADVANTAGES.

Pener, M. P. and Orshan, L. (Dept. Zool.,Hebrew Univ., Jerusalem, Israel)

Short days and/or relatively low temperatures induced mating behaviour and growth of the accessory genital glands, thus, terminated aestival reproductive diapause in O. miniata males. Long days and/or high temperatures maintained sexual inactivity and diapause (practical absence of mating behaviour and small accessory glands). Judged from induction or cessation of the mating behaviour, appropriate repeated changes of the photoperiod and/or the temperatures terminated, reinduced, or even reterminated and reinduced again reproductive diapause in the same males. Changes of the dimensions of the accessory glands were also reversible, at least to some extent. Regardless of previous conditions and state (males in diapause, or in full reproductive activity after prior termination of the diapause), intermediate conditions of photoperiod and temperatures induced intermediate states with mild mating behaviour and intermediate dimensions of the accessory glands. Such intermediate states persisted as long as the intermediate conditions were provided. An endogenous trend to complete diapause development and to terminate reproductive diapause does not exist in the males of this grasshopper; the role of the environmental cues is determining, not just modifying. These cues seem to "switch on" or "off" (partially or fully) the neuroendocrine system, especially the corpora allata. The reversibility probably reflects a relatively simple causal relation between diapause controlling extrinsic and intrinsic factors. This kind of reproductive diapause is probably primitive, but it may have adaptative advantages; the same mechanism can terminate diapause earlier at higher latitudes or altitudes where temperatures are lower and later in warmer areas or in lowlands.

4S-1,4 SEASONAL CONTROL OF NYMPHAL DIAPAUSE IN THE SPRING GROUND CRICKET (PTERONEMOBIUS NITIDUS). Tanaka, S. (Dept.Ent., Oregon State Univ., Corvallis,97331 USA)

To test some of the hypotheses derived from experimental results in the laboratory (Tanaka,1978a,b, & 1979), a field census and some experiments with field collected animals were undertaken at Hirosaki, Japan, in 1976-1978. In autumn, nymphs ceased molting when the temperature was still above the threshold for morphogenesis, supporting the hypothesis that nymphs enter diapause in response to environmental cues. Diapause intensity of the penultimate instars gradually decreased towards the end of autumn and stopped changing in early Nov. A further decrease in diapause intensity occurred after the winter solstice under the cover of snow. The diapause induced in autumn was then terminated in spring irrespective of the photoperiod but reinduced at a later instar when kept in a photoperiod shorter than 14 hrs at 20°C. Namely, in order to mature smoothly, the overwintered nymphs required a 14 hr or longer photoperiod. This supports the idea that the short-day/long-day requirements are the main device to maintain the univoltine life cycle of this species.

4S-1,5 DEVELOPMENTAL STRATEGIES IN BRITISH DICTYOPTERA : SEASONAL VARIATION. Brown, V.K.

(Department of Zoology and Applied Entomology, London, U.K.)

There are three species of indigenous cockroaches in the British Isles belonging to the genus Ectobius. E. panzeri has a univoltine life cycle, whilst E. lapponicus and E. pallidus have semivoltine cycles, overwintering as an egg and an intermediate nymphal instar. In E. pallidus a range of instars may overwinter, although the exact composition of an overwintering population varies from season to season. A number of developmental pathways may be defined, involving both quiescence and diapause. The proportion of an overwintering instar following each pathway also varies seasonally. In 'advanced' years higher proportions of the later instars enter diapause. The ecological significance of the different developmental strategies is discussed.

4S-1,6 DIAPAUSE AND GEOGRAPHIC VARIATION IN A LEAF BEETLE. Ando, Y. (Lab. Ent., Fac. Agr., Hirosaki Univ., Hirosaki, 036 Japan)

In Atrachya menetriesi, the egg diapause as a mechanism for overwintering involves seasonal changes in thermal response. The diapause may undergo reversible changes in its intensity before it is completed. The intensity decreases at a low temperature, but increases again when the eggs are transferred to a high temperature. Owing to this reversibility, the untimely termination of diapause before winter is effectively prevented. Moreover, a low temperature close to 0°C is not effective unless the eggs have experienced a period of moderate temperatures, say 4 - 10°C. This regulatory system is thus delicately tuned to the seasonal changes of environment. Some eggs hatch without arrest, the rate of which increases from north to south. There is also a high negative correlation between the egg weight and the local temperature conditions. Time required from the onset of postdiapause development to egg laying increases from north to south. It seems that these geographic variations represent adaptation to the local heat units.

4S-1,7 DIVERSITY IN SEASONAL STRATEGIES.

Tauber, Maurice J. and Tauber, Catherine A. (Dept. Ent., Cornell Univ., Ithaca, New York 14853, U.S.A.)

Longitudinally and latitudinally widespread species have evolved complex sets of life cycle characteristics that vary geographically to adapt populations to local conditions. Populations of two wide-ranging North American species show gross variation in their (1) thermal requirements for development, (2) photoperiodic regulation of dormancy, and (3) degree to which food influences the rate of reproduction.

Intrapopulation variation in the three factors can be either continuous or disjunct (resulting in polymorphic life cycle patterns). Both forms of variation appear to be influenced by natural selection.

4S-1,8 SEASONAL AND GEOGRAPHIC ADAPTATIONS OF THE PITCHER-PLANT MOSQUITO, WYEOMYIA SMITHII.

Bradshaw, W. (Dept. Biol., Univ. Oregon, Eugene, OR 97403, USA)

From the Gulf of Mexico to northern Canada, the mosquito, *Wyeomyia smithii*, restricts its pre-adult development to the confines of the leaves of the carnivorous pitcher plant, *Sarracenia purpurea*. Because of this specialized habitat, much of the between-population variation in life-history tactics reflects adaptation to geography rather than to local micro-habitat. Larvae of *W. smithii* overwinter in third or fourth instar diapause whose onset, maintenance, and termination is regulated by photoperiod. Northern *W. smithii* experience longer winters and shorter growing seasons than southern populations. Adaptation to geography has resulted in longer critical photoperiods, more conservative response to photo- and thermoperiodic stimuli, and polymorphic developmental options among northern populations. Throughout its range, *W. smithii* is capable of maturing at least its first clutch of eggs without a blood meal. Northern females lay most of their eggs soon after metamorphosis; southern females lay few eggs immediately, but, unlike northern females, take blood meals and spread out their reproductive effort over a longer period of time. Prey captured by the host leaf serve as the ultimate source of larval nutrients and active prey capture is restricted to a 2-4 week period when individual leaves are young. Either low prey capture or high larval densities may result in retarded larval development or decreased metamorphic success. Density-dependent selection is intense among southern larval populations but this selection abates with increase latitude or altitude. The life-history tactics exhibited by *W. smithii* are thus consistent both with bet-hedging and with r- and K-selection.

4S-1,9 GEOGRAPHIC DIVERSITY IN THE LIFE CYCLE OF THE COLORADO POTATO BEETLE: A STUDY OF SEASONAL ADAPTABILITY.

de Wilde, J. and Hsiao, T. (Dept. Entom., Agricultural Univ., Wageningen, Netherlands)

The Colorado potato beetle, *Leptinotarsa decemlineata* (Say), most probably originated in Mexico and moved northward with the Conquistadores. It fed on wild Solanaceae in the Rocky Mountains foothills, transferred to the cultivated potato by 1854, and reached the Atlantic coast by 1876. It was repeatedly introduced to Europe, established at Bordeaux in 1921, and now is distributed as far east as Anatolia, Azerbaijan, and the Volga region. In North America it is now found between 15 and 55° North Latitude and in Eurasia between 35 and 60°. The extent of geographic differentiation developed in the populations of both continents and some crucial factors in its life cycle strategy responsible for its successful invasion of new regions were investigated. In comparative laboratory and field studies, factors that influence immediate and long-term survival were considered, including (1) synchronization of diapause with the unfavorable season (autumn) and of activity with the favorable season (spring), (2) maximum exploitation of the biotype in the absence of dry or cold seasons, and (3) variation of host plant specificity among geographic populations in North America and Eurasia. Field observations of reproduction, population development, walking and flight activity, and diapause were made at five locations in Europe. Agreement with the laboratory data on photoperiodism was observed. New elements that required consideration were "hunger flights" and "crop-induced generations." Sharp differences existed between the infestations in cool-rainy and dry-warm-sunny climates. In the latter, alertness, oriented flight, and rapid population increase of the beetles provide a situation in which potato growing must rely completely on control of the Colorado potato beetle.

4S-1,10 ANALYSIS OF CODLING MOTH PHENOLOGY IN RELATION TO LATITUDE, CLIMATE AND FOOD AVAILABILITY

Riedl, H. (Dept. of Entomological Sciences, Univ. Calif., Berkeley, CA 94720, U.S.A.)

The seasonal phenology of the codling moth, Laspeyresia pomonella L. varies considerably throughout the range of its distribution. At its northern limits in North America and Europe, L. pomonella is essentially univoltine, but generations increase towards the southern distributional limits. As in other insects with a facultative diapause the photoperiodic reaction is the principal timing mechanism which synchronizes the moth's life cycle with seasonal rhythms of climate and food availability. Similar to the situation in Europe, the photoperiodic reaction in North American codling moth populations displays clinal-type variation. Intrapopulation variance in diapause response appears to be similar in populations of different geographic origin. Seasonal temperature conditions preceding the date of the critical photoperiod govern the number of generations possible under local conditions. Therefore, the seasonal heat unit total at the time of diapause initiation can be directly related to voltinism, the proportion of diapausing larvae and the variance of population curves for climatically different years. Voltinism may also be affected by fruit density in unmanaged orchards. There is evidence for a density-dependent diapause response in 1st brood larvae as a function of competition for a limited food resource. This mechanism determines whether a population is predominantly univoltine or multivoltine. Seasonal phenology varies also with the host as recent studies suggest. Populations from apple, plum and walnut from the same geographic area were found to represent distinct host races which differed in several biological parameters such as developmental heat requirements, critical photoperiod and behavioral characteristics.

4S-1,11 THE GENETIC BASIS OF DIAPAUSE.

Hoy, M.A. (Dept. Entomological Sciences, 201 Wellman Hall, Univ. Calif., Berkeley 94720 U.S.A.)

Considerable intraspecific variation in diapause attributes is found whenever it is looked for in arthropods. The genetic basis of that variability is readily demonstrated by the rapid response to artificial selection exhibited by many, if not most, arthropod species. "Nondiapause" strains of the gypsy moth (Lymantria dispar (L)) (Lepidoptera: Lymantriidae) and of Metaseiulus (= Typhlodromus) occidentalis (Nesbitt) (Acarina: Phytoseiidae) were selected within a few generations. The genetic basis of diapause in these species is investigated. Because diapause is a complex trait, is a threshold character, and is usually determined by more than one allele, such analyses are difficult. However, the practical and theoretical benefits of this knowledge warrant considerable effort.

4S-1,12 MICRO-EVOLUTION OF THE MIGRATORY TENDENCY, PHOTOPERIODIC RESPONSE AND GROWTH RATE OF THE PEA APHID, ACYRTHOSIPHON PISUM.

Lamb, R.J. (Agriculture Can., Winnipeg, Man., Canada R3T 2M9)

Aphid clones drawn from different habitats or geographic locations often show stable differences in ecologically significant traits. These differences are thought to reflect evolutionary adaptations to local conditions. Geographic variation in photoperiod response, growth rate and migratory tendency, and seasonal variation in migratory tendency for pea aphid populations are described. Studies of within-clone and within-family variation support the conclusion that much of the among-clone variation is due to genetic differences among clones. However, it is shown that within-population variation for such traits can be substantial and therefore observed geographic variation should be considered cautiously unless based on adequate samples of clones from each geographically distinct population. The adaptive significance of some life history and behavioral traits identified for pea aphids are reconsidered in the light of within-population variation.

4S-1,13

ALLOCATION OF REPRODUCTIVE ENERGY IN RELATION TO THE LIFE HISTORIES AND PATTERNS OF ENVIRONMENT OF WATER-STRIDERS (GERRIDAE). Vepsäläinen, K. (Dept. Genetics, Univ. Helsinki, P.Rautatiekatu 13, 00100 Helsinki 10, Finland)

Life history theories sort out species belonging to a set of closely related ones. The place of each species depends on its position in the environmental spectrum relative to other species. E.g., the theory of island biogeography spreads out the species onto the *r-K* continuum. Life history theories also predict differences in energy investment and allocation between the species, according to the stability and predictability of their environments.

In the present work some of these predictions are tested with water-striders (Gerridae). The habitat preferences and life histories as well as the relative position of the European species on the *r-K* continuum are well known. Energy contents of eggs, various larval instars and imagos of several species were studied, and the results were compared to the position of each species on the continuum of environmental stability and predictability.

4S-1,14

BEHAVIOR AND LIFE HISTORIES: GEOGRAPHIC VARIATION IN MILKWEED BUGS (*ONCOPELTUS*). Dingle, H. (Dept. Zool., U. Iowa, Iowa City, IA 52242, U.S.A.)

Behavior can make important contributions to life history flexibility. I consider migration and diapause and their relation to life table statistics in tropical and temperate populations of *Oncopeltus fasciatus*. There is little diapause or migration in the tropics, a response to equable conditions. Migration and a highly variable diapause occur in temperate populations in response to environmental variability. Classic life table statistics such as birth and death rates differ very little among populations, except as influenced by migration or diapause, suggesting that important elements of life history strategies are behavioral. Quantitative genetic analysis indicates that the observed phenotypic variability is influenced by both environmental and genetic components.

4S-2,15

SPATIO-TEMPORAL DYNAMICS OF A THISTLE-FEEDING LADY BEETLE (*HENOSEPILACHNA PUSTULOSA*) IN A COOL TEMPERATE CLIMAX FOREST, WITH SPECIAL REFERENCE TO THE ROLE OF ADULT DISPERSAL AMONG PATCHES. Nakamura, K. (Ecol. Lab., Dept. Biol., Kanazawa Univ., Kanazawa, 920 Japan)

Population dynamics of *H. pustulosa* living in a patchily distributed habitats was studied by construction of life tables. Adult movements between patches of food plants were analysed by an intensive marking-recapture program. During the period of 4-year study the size of population under study remained fairly constant at a relatively low level and it never reached to such a high density where severe intraspesific competition for food occurred (Nakamura and Ohgushi, 1979). Reslts of the key factor analysis indicated that the stabilization of population size was attained through the density-dependent processes operating in the inter-patch dispersal and oviposition by overwintered adults. The demographic attributes of *H. pustulosa* will be discussed in relation to the stability and spatial structure of their habitats.

4S-2,16

COMPARATIVE DEMOGRAPHY OF LOCAL POPULATIONS OF A PHYTOPHAGOUS LADY BEETLE, HENOSEPILACHNA PUSTULOSA (KŌNO), LIVING UNDER DEFFERENT HABITAT CONDITIONS.

OHGUSHI, T. and SAWADA, H. (Ent. Lab., Kyoto Univ., Kyoto, 606, Japan)

A field study was carried out on the population dynamics of a thistle-feeding lady beetle, Henosepilachna pustulosa, living in different valleys of the Ado river,central Japan. H. pustulosa has one generation a year and exclusively feeds on the thistle,Cirsium kagamontanum, along the riverside in the study area. Population parameters estimated by the Jolly-Seber method and life history phenomena showed definite changes from upstream to downstream habitats. The local populations in upstream habitats,as compared with those in downstream habitats, were characterized by longer longevity of overwintered adults, delayed emergence as adults, lower reproductive rate and higher survival rate of adults from emergence to the reproductive season in the following spring. In accordance with those changes in population parameters and life history phenomena, habitat conditions also showed some variations. Vegetation was more complex and the host plant population was more stable in its spatial disposition and annual biomass in upstream habitats than those in downstream habitats. Reproductive rate among different habitats was detected to be mainly determined by the magnitude of arthoropod predator pressure which was closely dependent on habitat conditions, and survival rate of adults from emergence to the reproductive season was detected to be mainly determined by longevity of overwintered adults and time-specific effect of predation. Regulatory mechanisms in year-to-year variations in population size in both upstream and downstream habitats will also be discussed.

4S-2,17

Maternal age as a factor in population dynamics:the production of dispersers by an aphid.

MacKay, P.A. (Dept. Ent., Univ. Manitoba, Winnipeg, Manitoba, Canada).

Apterous (wingless) pea aphids, (Acrythosiphon pisum (Harris)) respond to high population densities by producing alate (winged) aphids able to disperse. Maternal age affects the level of this response. Laboratory data show that early-born aphids of apterous mothers are much more sensitive than late-born aphids and produce higher proportions of alatae. It is hypothesized that this variation is important in regulating alata-production in natural populations. Any factor which affects adult age structure in a population will modify the production of dispersers by altering the proportions of early-born and late-born aphids in the next generation. Field samples indicate that this is indeed the case and that population age or habitat age is one such factor. Apterous adults were collected from natural populations of aphids infesting alfalfa fields of varying age. These adults were of unknown age. Their progeny, the first laboratory generation, were therefore an unknown mixture of early-and late-born. Their response to a standard alata-producing stimulus was lower in increasingly older populations. When the second laboratory generation, all of which were early-born, were tested, no such relationship could be found. This indicates that the differences measured previously were not genetic in origin. Maternal age effects appear to be the only suitable explanation. Survival is apparently better in older populations resulting in higher proportions of late-born and therefore less sensitive aphids. Samples of field populations provide further evidence that this is the case. Older populations had higher densities. However, they had a lower percentage of alate adults. Based on density effects alone, these populations might have been expected to have a higher percentage of alatae. Maternal age effects appear to be moderating density effects and lowering the level of production of dispersers from older fields.

4S-2,18

BEHAVIOUR AND THE DISTRIBUTION AND DYNAMICS OF CABBAGE BUTTERFLIES.

Jones, R.E., (Dept.Zool., James Cook Uni., Townsville. Australia.)

Pieris rapae is a vagrant species whose adult searching and oviposition behaviour determines the distribution, and to some extent the success, of juvenile populations.

Searching and oviposition behaviour on a small spatial scale was studied in Vancouver (Canada), and in Canberra (Australia). Butterflies from the two populations showed similar host plant preferences but very different search behaviour - Canberra butterflies tended to fly in straight lines and were relatively unresponsive to hosts, while Vancouver butterflies were undirectional and relatively responsive. As a result, Vancouver butterflies produced a highly aggregated egg distribution and were slow to disperse, while Canberra butterflies produced a much less aggregated egg distribution and covered greater distances. The differences are adapted to differences in weather patterns and in the larval population dynamics between the two places. When the Canberra study was extended to examine behaviour over longer times and distances, it became apparent that although butterflies were highly directional on any one day, they changed direction on successive days, indicating that straight-line flight was used simply as a device for covering ground and generating the appropriate egg distribution; the butterflies weren't going anywhere, and the actual direction of flight was unimportant.

Once the eggs were laid, their survival is influenced very strongly by the behaviour of the larvae, which are egg cannibals. Cannibalism acts as a major density-dependent mortality factor; the movement patterns of larvae on the plant ensure that younger larvae have the greater effect. If, despite this check on population growth the plant is destroyed, the larval searching behaviour is well-adapted to finding new hosts, given the uncertain but usually clumped fashion which host plants are distributed.

4S-2,19

PATTERN OF HABITAT UTILIZATION AND POPULATION DYNAMICS OF THREE *PIERIS* BUTTERFLIES, *P.RAPAE*, *P.MELETE* AND *P.NAPI*, LIVING IN THE SAME AREA. OHSAKI,N.(Ent. Lab., Coll. Agr., Kyoto Univ., Sakyo, Kyoto 606, Japan)

The adult populations of three *Pieris* butterflies, *P.rapae, P.melete* and *P.napi,* were studied throughout the flight seasons in an area of their coexistence, about 3 x 1.5 km, where was in a farm village in mountains. Field study was used by the mark-and-recapture method.

The habitats were qualified by the four factors, i.e., oviposition plants, adult nectar plants, roosting-sites and light conditions. Three *Pieris* species were more likely to partition habitat resources rather than competing for them.

The habitat structures of each species in respect of time, space and stability to weather changes were much different each other in the same area. The habitat of *P.rapae* was temporary, localized and unstable. While, that of *P.melete* was more permanent, widespread and stable than that of *P.rapae*. *P.napi* seemed to live in the intermediate habitat, i.e., permanent, localized and stable one.

Sexually immature, mated females of *P.rapae* after teneral stage showed a migratory flight, and reproductive females begun to lay eggs concentrically at sunny places of newly suitable areas within a short period. Females of *P.melete* seemed to disperse gradually from emerged sites and they continued to lay some constant numbers of eggs for more than ten days over a wider area. *P.napi* appeared to be more resembled to *P.melete* than to *P.rapae.*

The number of generations of *P.rapae, P.melete* and *P.napi* were estimated to be about six, three and three, respectively. Seasonal fluctuations in the number of adults were influenced by the stability of their habitats, i.e., the population size fluctuated sharply in *P.rapae*, but it was much more stable in *P.melete* and *P.napi*.

4S-2,20

DIFFERENTIAL EFFECTS OF AGROECOSYSTEM STRUCTURE ON THE DYNAMICS OF THREE SOYBEAN HERBIVORES. Stinner, R, Wilson, K., and Regniére, J. (Dept. Entomol., NCSU, Raleigh, NC 27650)

Comparative studies of three soybean herbivores (*Heliothis zea*, *Epilachna varivestis* and *Popillia japonica*) have led to numerous conclusions concerning the relative importance of patchiness and coarseness in agroecosystem structural features to the dynamics of these species. Features considered include ratios of crop to non-crop lands, spatial distribution and phenological sequences of food resources and overwintering habitats, variability in crop mix and cultural practices, and the effects of weather patterns. These various features have strikingly different effects on the population dynamics of each species. For some features these effects can be *a priori* determined by cursory examination of the life history, but many of the effects (although severe) are either difficult to elucidate due to interactions, or are not easily measured or experimentally manipulated. In such cases, the use of a systems approach for developing alternative hypotheses in the form of mathematical models is required. Examples are offered of both the differential effects of these structural parameters on the dynamics of the selected species, and the methodology used to elucidate these effects.

4S-3,21

THE POPULATION STRUCTURE OF PEST AND NON-PEST *COLIAS PHILODICE ERIPHYLE* (LEPIDOPTERA: PIERIDAE). Tabashnik, B. and Watt, W.B. (Dept. Biol. Sci., Stanford Univ., Stanford, California, 94305, USA)

Mark-release-recapture techniques were used to study alfalfa pest populations and non-pest populations of *Colias philodice eriphyle* in Colorado, USA. Study sites for the pest populations were at 1770 m elevation. Non-pest populations were studied at 2710 m. The data were processed by computer, using Jolly's stochastic method. The results show that pest and non-pest populations have different population structures:

(1) The low elevation pest populations have about 5 overlapping generations per year. The higher elevation non-pest populations have 2 discrete generations per year.

(2) The density of pest populations is relatively stable from year to year. Non-pest population density varies dramatically between years.

(3) Individual butterflies in pest populations have smaller dispersal distances than individuals in non-pest populations.

Explanations for the differences in population structure will be discussed. The results of this study suggest some general principles involved in the evolution to pest status.

4S-3,22 SYNTHETIC EFFECT OF BIO-ENVIRONMENTAL SYSTEM ON LOCUST POPULATION DYNAMICS

Ma Shin-chun (Ma Shijun) (Institute of Zoology, Academia Sinica,
Beijing, China.)

The insect population fluctuation may be considered as the breaking of proportional balance among these interlocked components of the whole bio-environmental system. In nature, the effect acted by any single factor on insect population fluctuations will be included the influence of other factors at the same time.

It is a complex probability problem between the occurrence of optimal environmental conditions and requirement of species characters to make up on insect outbreak. Suppose the outbreak of an insect species is controlled by N factors, then the outbreak frequency will be decreased as controlling variables increase; otherwise, the frequency will increase adversely. Therefore, some species have more outbreaks than other groups in which outbreaks only occasionally occur, but rapidly.

The change of population numbers of the Oriental Migratory Locust caused by the action of the whole bio-environmental factors, including density-induced regulation, in relation to the conditions of environment and properties of the insect species, and also the variables of time and space is much complex, but their regularity have been found quite clearly.

4S-3,23 POPULATION DYNAMICS OF RICE LEAFHOPPERS: A COMPARATIVE STUDY.

Kuno, E. (Col. Agric., Kyoto Univ., Kyoto, 606 Japan) and Hokyo, N. (Okinawa Agric. Exp. Stat., Naha, 903 Japan)

The brown planthopper (BPH), *Nilaparvata lugens* Stål, and the green rice leafhopper (GLH), *Nephotettix cincticeps* Uhler, are both known as serious pests of rice in Japan. BPH causes destructive "hopperburn" in rice fields due to collective sap-sucking at the occasion of outbreak, while GLH does damage mainly by transmission of the rice dwarf disease. Comparative analysis of their field population dynamics revealed conspicuous differences existing between these two species in various aspects of population properties. The BPH population is characterized by low initial density, high population growth rate, contagious spatial distribution and violent fluctuation from year to year, being regarded as much more "opportunistic" than the GLH population which in contrast shows extraordinarily high stability and homogeneity. Some experiments indicated that high population stability in GLH is the outcome of specific self-regulation due to density-dependent dispersal of adults. Ecological significance of these population characteristics is discussed in relation to the specific mode of life and status as a pest of each species. Comparison of some characteristics is also made between Japanese and tropical populations of *Nilaparvata* and *Nephotettix*.

4S-3,25 COMPARATIVE STUDY ON POPULATION DYNAMICS OF SOME GALL MIDGES INHABITING BROAD-LEAVED EVERGREEN FOREST.

Yukawa, J. (Entomol. Lab., Fac. Agr., Kagoshima Univ., Kagoshima 890, Japan)

It has been emphasized that investigations of wild insect populations are necessary to promote a better understanding of natural regulation mechanisms in insect populations, but insect populations of economically unimportant species have not been extensively investigated under natural conditions. Since 1970, natural populations of several gall midge species inhabiting broad-leaved evergreen trees have been investigated at several places in Kagoshima city and its vicinities. In the present paper, population dynamics, life history strategies and behavioural aspects of these species are compared with one another, and life tables and other ecological attributes are analyzed and discussed. The following three gall midge species of the supertribe Asphondyliidi are mainly treated here:
Asphondylia sphaera Monzen producing fruit galls on *Ligustrum japonicum* and *L. obtusifolium*,
Pseudasphondylia neolitseae Yukawa producing leaf galls on *Neolitsea sericea*, and
Daphnephila machilicola Yukawa producing leaf galls on *Machilus thunbergii* and *M. japonica*.

4S-4,26 PREY DISTRIBUTION AS A FACTOR DETERMINING THE CHOICE OF OPTIMAL FORAGING STRATEGY.

Iwasa, Y., Higashi, M., Yamamura, N. (Dept. Biophysics, Fac. Science, Kyoto Univ., Kyoto 606, Japan)

The optimal-patch-use problem is investigated by use of a stochastic discrete model. We first consider three elementary strategies, differing in when to leave the patch in which the predator has been foraging, namely, (1) a fixed time has passed, (2) a fixed number of prey has been captured, and (3) the interval between two successive catches has exceeded a fixed time. Each of these fixed quantities has the value that optimizes the strategy concerned, given certain conditions. The optimized strategies are compared to determine the most efficient. It is shown that ranking of the strategies depends critically on the type of prey distribution between patches, other things being equal; e.g. strategy (3), the best when the variance of prey distribution is sufficiently high, tends to be the worst when the variance is small. The above strategies do not use full information for estimating the number of prey remaining in the patch that might be used by a more sophisticated predator. The statistical decision theory reveals, however, that the number of prey already taken (n) and the total time spent foraging (t) in the patch are the minimal sufficient statistics for estimating the number unexploited. Thus, the sophisticated predator should leave the patch when the estimator r(n,t) falls below a certain value that optimizes the strategy adopted. However r may be a function of n or t alone, depending on the type of the between-patch distribution of prey. In particular, r is a function of both n and t for an uneven (negative binomial) prey distribution, whereas, it is a function of n only for a comparatively uniform (binomial) distribution. In the lattern case, the best strategy is reduced to elementary strategy (2). If, on the other hand, the distribution is random (Poisson), r is a function of t only. Then the best strategy becomes simply elementary strategy (1).

4S-4,27 FORAGING STRATEGY OF NON-OMNISCIENT PREDATOR IN A CHANGING ENVIRONMENT.

Inoue, T.(Entmol. Lab., Col. Agr., Kyoto Univ., Sakyo, Kyoto 606, Japan)

Almost all the models of "optimal patch use" put on the implicit assumption that predators have the complete information on the spatial distribution of their prey. Factors dealt with are traveling time among patches and depletion of prey due to predation, but the temporal change in the prey distribution caused by other factors than the depletion is not considered. In the natural conditions, however, the prey distribution is changing from time to time and predators do not completely know this distribution (e.g. Royama 1970, Heinrich 1976). To deal with the situation, I propose foraging strategy models of "non-omniscient predator in a changing environment". In these strategies, predators forage according to the procedure: 1) collecting information, 2) storing the information collected, 3) deciding upon tactics with the estimates of prey densities, and 4) excuting the tactics employed. There are generally two types in the third process: comparing absolutely the estimate for the staying patch with the threshold density specific to the predator to decide between stay and departure, and comparing relatively all the estimates to select the best patch. As examples of the two types, models for ambush and searching strategies will be given. In the former, the hunger level at which a predator goes out from the patch where it sit-and-waits is the threshold value. And in the latter, two parameters, TM (memory time) and CM (memory capacity reserved for each patch) are the "data windows" to estimate prey densities. The above two models are able to describe well the foraging behaviours of a mantid (Inoue 1979) and the great tit (Smith and Sweatman 1974) respectively, but their behaviours are not the optimal ones predicted by the models. The reasons for these discrepancies will be discussed.

4S-4,28 APPLICABILITY OF CURRENT FORAGING THEORY TO PREDATORY ARTHROPODS, WITH COMPARISONS TO PREDATORY VERTEBRATES.

Schoener, T.W. (Dept.Zool., Univ.Washington, Seattle, Wa. 98195)

Much of the early optimal foraging theory was implicitly conceived for and applied to vertebrate predators. The suitability of this theory for solitary terrestrial predatory arthropods is examined using a comparison of the major ways in which those organisms differ in their feeding and energetics from terrestrial vertebrate predators. Consequences for feeding strategies of the following differences are especially emphasized: 1) arthropods typically feed on prey large relative to their own body size; 2) arthropods (excluding parasitoids) are more frequently sit-and-wait (ambush) predators than are vertebrates; 3) arthropods have smaller caloric expenses than do most vertebrates, they have smaller per-gram expenses than birds or mammals, and they can survive long periods of food deprivation better than many vertebrates; 4) univoltine arthropods can adjust their life cycles to that of their prey, whereas many vertebrates cannot; 5) arthropods are more subjected to risk of predation than are many vertebrates -- they not only compete with vertebrates for food but may be predated upon by them. Consequences of these differences, especially the last, are speculated to result in systematic differences in population dynamics. The survival of terrestrial arthropod predators in the face of the evolution of terrestrial vertebrate predators is noted and some explanations are offered.

4S-4,29 CONCLUDING REMARKS: FORAGING BY GENERALISTS & SPECIALISTS. *Price, P. W.* (Mus. N. Arizona, Flagstaff, Arizona, U.S.A.)

The great diversity of foraging strategies observed among insects is reviewed and summarized. Emphasis is placed on differences in foraging between generalists and specialists, the cues they use, and the environmental factors that influence foraging efficiency. Foraging behavior of predators and parasitoids has important implications for prey and host ecology and evolution. These are considered and it is emphasized that more research is needed in this area.

4S-5,30 Spatio-temporal structure of an acarine predator-prey system. *Takafuji*, A.(Lab. Appl. Ent., Okayama Univ., Okayama, 700 Japan), Fujita, K.(Lab. Appl. Ent. & Nemat., Nagoya Univ., Nagoya, 464 Japan), Inoue, T.(Ent. Lab., Kyoto Univ., Kyoto, 606 Japan) and Narimatsu, S.(Lab. Appl. Ent., Okayama Univ., Okayama, 700 Japan)

Spatio-temporal structure was experimentally studied in the interactive system between the predacious phytoseiid mite *Phytoseiulus persimilis* and its prey mite *Tetranychus kanzawai* on bean plants which were distributed discontinuously. The ease with which the predators could move between plants and the number of plants (patches) in the experimental universe were varied to evaluate their effects on the behaviour of the interactive system. Relationships between the spatial distributions of the predator and its prey among the patchily distributed plants in these experimental systems were analyzed by a new index proposed by Fujita (unpublished) based on the interspecies mean crowding, to elucidate the predator dispersal in response to the spatial variation in prey density and its influence on the stability and persistence in the predator-prey system.

4S-5,31 DIVERSITY-STABILITY RELATIONSHIPS IN THE LABORATORY EXPERIMENTAL SYSTEMS. *Fujii*, K.(Inst. Biol. Sci., Univ. Tsukuba, Sakura-Mura, Ibaraki, 305 Japan)

To investigate the role of ecosystem's diversity (in terms of both the number of food levels and the number of species at each food level) in the system's stability, I constructed laboratory experimental systems consisting of at most three food levels (resource(bean), herbivore(bean weevil), and carnivore(parasitic wasp)). The maximal diversity at resource level was three (*Phaseolus radiatus*, *P. vulgaris*, and *Vigna sinensis*), that at herbivore level was three (*Callosobruchus chinensis*, *C. maculatus*, and *Zabrotes subfasciatus*), and that at carnivore level was two (*Heterospilus prosopidis* and *Anisopteromalus* calandrae). By various combinations of these species, I set up a number of systems ranging from simple to complex ones, and followed the dynamics of these systems. When the system stability was measured in terms of species persistence in the system and also of the dynamics of each species during its presence in the system, no simple diversity-stability relationship was observed. Systems behaviors were more dependent on the carnivore's species specific utilization pattern, which could be modified by the kinds at resource level and by both intra- and interspecific competitive pressures. For example, *A. calandrae*-*Z. subfasciatus*-*P. radiatus* system was very stable. However, with *V. sinensis* at resource level, the system easily crashed to the extinction of *A. calandrae* and *Z. subfasciatus* due to the super efficient utilization of *Z. subfasciatus* by *A. calandrae*. With *P. vulgaris* at resource level, *A. calandrae* soon disappeared from the system due to its very inefficient utilization. The additions of other species at herbivore and/or carnivore level in the above systems did not change the overall trends of system dynamics.

4S-5,32 THE STABILITY OF PARASITOID-HOST INTERACTIONS. Hassell, M.P. (Dept. of Zoo. & Appl. Ent., Imperial Coll., London)

Some parasitoid-host interactions conform closely to the notion of a stable equilibrium around which the populations fluctuate to a limited extent. Models of such interactions point to several factors affecting stability. Foremost amongst these is the way that host and parasitoid populations are distributed in a heterogeneous environment.

4S-5,33 PROPERTIES OF INSECT DOMINATED FOOD WEBS

Pimm, S.L. (Biol. Sci., Texas Tech Univ., Lubbock, Texas 79409, U.S.A.).

Food webs are representations of which species interact, within a community. Webs are often presented as testimony to the apparent complexity of ecological relationships. Such complexity does not preclude the existence of patterns nor prevents our attempts to explain these patterns. Theoretical studies predict, and analyses of literature confirm, that food webs composed of vertebrates and their prey show a number of features: (1) Food chain lengths are short. (ii) Omnivory (defined here as feeding on more than one trophic level), is rare. (iii) Omnivors that feed on prey seperated by more than one trophic level are also rare. (iv) Species interactions are not grouped into 'compartments', characterised by strong species interactions within compartments and weak interactions between compartments.

Webs composed of plants, insect herbivors and their parasitoids and hyper-parasitoids have longer food chains and more complex patterns of omnivory. These features may be permitted by singular features of host-parasitoid interactions which contribute to dynamical stability: (i) interactions coefficients are small and (ii) parasitoid searching behaviour can lead to density-dependent effects through 'pseudo-interference'. However, the complexity of insect dominated food webs may also contribute to the large population fluctuations often observed in insects.

4S-6,34 COMMUNITY STRUCTURE IN WATER-FILLED TREE-HOLES IN EUROPE AND AUSTRALIA - SOME COMPARISONS AND SPECULATIONS. Kitching, R. L. (Griffith Univ., Nathan, Queensland, Australia 4111).

The trophic relationships of and interactions among the insects living in water-filled tree-holes in Western Europe and Australia will be discussed centring on studies made in Oxford, U.K., and Brisbane, Queensland. The perhaps suprising similarities of the two faunas are i;;ustrated and compared with physico-chemical features of the micro-environment in both instances.

Two theories of community structure will be examined, the first examining concepts of the niche and, the second, the relationship between energy input and trophic complexity. The value of each as an explanatory tool in tree-hole studies will be considered.

A general dynamic model of the system will be presented which not only permits useful synthesis of information derived from tree-holes studies but, also, is of great heuristic value as a tool in systems ecology, describing as it does a natural community of almost canonical simplicity.

4S-6,35 THE MOSQUITO COMMUNITY INHABITING TREEHOLES IN SUBTROPICAL FLORIDA. Lounibos, L. P. (Fla. Med. Ent. Lab., P.O. Box 520, Vero Beach, FL 32960 USA)

Water-filled holes in oak (Quercus spp.) trees provide the principal larval habitats in native woodlands of peninsular Florida for four species of mosquitoes. Regular samples from forty treeholes revealed that the rank order of incidence: Corethrella appendiculata > Aedes triseriatus > Orthopodomyia signifera > Toxorhynchites rutilus was maintained throughout the greater portion of an annual cycle, except when vernal rains ended a period of drought, hatched quiescent aedine eggs, and allowed A. triseriatus prey a temporal escape from their principal predator, C. appendiculata. In laboratory simulations third and fourth instars of C. appendiculata preyed selectively on first and second instars of A. triseriatus and consumed an average of sixty-three mosquito prey per predator. In treeholes subjected to a non-disruptive censusing regimen for 1.5 to 2.5 years, there was a significant negative correlation between the abundances of C. appendiculata and A. triseriatus. The strongest negative correlations occurred where the mean abundances of predator and prey were similar; in other holes either C. appendiculata was rare relative to A. triseriatus, or O. signifera replaced A. triseriatus as the common prey species.

4S-6,36 NEOTROPICAL HELICONIA INSECT COMMUNITIES. Seifert, R., Beaman, N. (Bi.Sc., GWU, Washington, DC)

Some plants in the genus Heliconia have upright floral bracts which collect water and harbor an aquatic insect community variously consisting of fly larvae, beetle larvae and adults, cockroaches, earwigs, and mosquito larvae. We have studied different species of Heliconia from several locations from Costa Rica, Venezuela, Ecuador, Guadeloupe, Martinique, Trinidad and Tobago. Certain general patterns emerge from these studies. The insects do not show high levels of competition and some species are facultatively symbiotic with others. Further, movement rates among plants are low and we suggest that some insect populations represent collections of largely non-interbreeding demes. Finally, plant morphology and floral phenology are important structuring components for these insect communities. Heliconia species which have inflorescences with large amounts of water usually have mosquito-dominated insect communities.

4S-6,37 REGULATION OF BROMELIAD-INHABITING MOSQUITO POPULATIONS IN FLORIDA. Frank, J.H. and Curtis, G.A. (Fla. Med. Ent. Lab., Vero Beach, Florida 32960, U.S.A.)

Water-filled leaf axils of tank bromeliads provide habitat for the aquatic stages of many insect species in forested areas of the Neotropics. In southern Florida, an endemic bromeliad flora, and an endemic bromeliad-inhabiting insect fauna occur, but are depauperate in numbers of species. The relative simplicity of the bromeliad-insect ecosystem facilitates the task of understanding natural regulation of the insect populations.

For the bromeliads, population size and structure are affected primarily by the size and quality of stands of trees on which the bromeliads grow epiphytically. These same factors affect population size and structure of the insects, both directly and indirectly, by determining the carrying capacity of the environment. Seasonal and shorter-term fluctuations in the insect populations are determined primarily by rainfall pattern.

4S-6,38

THE ORGANISATION OF COMMUNITIES IN NEPENTHES. Beaver, R.A. (Dept.Biol., Univ.Zambia, Lusaka,Zambia)

Insects which fall into Nepenthes pitchers and drown, form the basis of complex food webs involving organisms in several phyla. Colonisation starts as the pitcher opens, and the maximum faunal diversity coincides with the maximum 'prey' input during the first few weeks after opening. The macrofauna is dominated in numbers of species, and usually in numbers of individuals per pitcher, by Culicidae (over 70 species recorded), but c.30 other dipteran species in 12 other families have been recorded, as well as a few species of Lepidoptera, parasitic Hymenoptera, Araneae and Acari (total 120–125 species). The great majority of these species are confined to Nepenthes pitchers for breeding (nepenthebiont species). The input of 'prey' to the pitchers is uneven in both space and time, but many nepenthebiont species are able to survive long periods without food and/or occur only as single individuals in the pitchers. A few nepenthexene species are opportunistic and take advantage of an occasional surplus of undigested 'prey' in the pitchers. Each pitcher usually only supports a single generation of arthropod inhabitants, but long distance dispersal is not necessary in each generation because the pitchers are more or less continuously renewed in the same locality over a period of years.
Studies of the fauna of three species of Nepenthes in West Malaysia show that the functional components of the food webs are very similar in each, but the taxonomic components may differ considerably. These differences can be related in part to the structure of the pitchers, but the different habitats in which the plants grow are also involved. The community organisation is determined by the interaction of the properties of the colonising organisms and the properties of their habitat.

4S-6,39

INTERACTION OF THE MOSQUITO, WYEOMYIA SMITHII, AND THE MIDGE, METRIOCNEMUS KNABI, WITH THEIR CARNIVOROUS HOST, SARRACENIA PURPUREA. Bradshaw, W. (Dept. Biol., Univ. Ore., Eugene, OR 97403, USA)

Wyeomyia smithii and Metriocnemus knabi live within the leaves of the carnivorous purple pitcher plant, Sarracenia purpurea. The host plant attracts and traps insect prey which serve as the basis of the food chain within the plant. M. Knabi acts as a decomposer and W. smithii as a grazer in the system. Both inquilines enhance the rate at which dead prey become plant-available nitrogen. The plant, in return, readily absorbs nitrogenous end products as well as carbon dioxide from the from the water and passes oxygen into it. The relationship between the plant and its inhabitants thus appears to be one of mutualistic interaction.

4S-6,41

Phytotelmata and mosquitoes vectors of selvatic yellow fever in Africa.

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Of the species of mosquitoes vectors of selvatic yellow fever in Africa, eight usually lay in tree hollows, one in breeding places formed by axils of plants with sheathed leaves and one in vegetable matter on the ground.

After describing the main characteristics of these larvae breeding places and then the physiological traits which enable these mosquitoes to adapt to preimaginal life in phytotelmata, the author outlines larvae population dynamics of one of these species: Aedes simpsoni, which lays in leaf axils: instability, considerable variations during the course of the year and also from one year to the next, without any close correlation, during the rainy season, with rainfall, and, finally, interaction of numerous factors: frequency and strength of rainfall, amount of available food, predatory action, etc.

4R-1,1

DISTRIBUTION AND ECOLOGY OF DESERT APIOCERID FLIES IN CALIFORNIA. Toft, Catherine A., (Dept. Zoology, Univ. California, Davis, CA 95616)

Apparently rare desert flies of the genus Apiocera (Apioceridae: Diptera) are locally common but have highly disjunct distributions associated with the location of desert springs or moist areas. These areas are widely separated, sometimes by hundreds of miles with intervening mountain ranges, in the Mojave Desert, Great Basin, and Central Valley of California. The phenology of courtship and breeding, which takes place in large aggregations around springs, is discussed, along with the possible significance of their disjunct distributions.

4R-1,2

ON SPATIAL PATTERNS IN SOME QUANTITATIVE TRAITS OF DROSOPHILA MELANOGASTER IN THE MAINLAND OF JAPAN . Chigusa,Sadao I.(Dept.Biol.,Ochanomizu Univ.,Tokyo,112 Japan)

In the Drosophila genus,spatial patterns in body weight and wing size so far are mostly similar.Wing size increases linearly with latitude. On a shorter scale,however, it may not always be recognized. In fact, we observed inverse latitudinal clines for two traits (wing size and sternopleural bristle number) of Drosophila melanogaster consistently for four years. Both traits were measured on 30 geographical populations. The latitudes of origin ranged from 33° to 40°North in the Mainland of Japan. In all experiments, flies were reared under strictly controlled conditions.Wild caught flies were also studied. The mean and the genetic variance were calculated based on 45 isofemale lines for each population. Coefficients of correlation between population mean and latitude of origin were around -0.6 and statistically significant for two traits,while the measurements taken on wild caught flies showed completely opposite trends,positive correlation which may correspond to a direction of natural selection, if any. The variance of genetic variance estimated for each of 30 populations was nearly two times larger than the value predicted by chance alone. An amount of selection pressure necessary to lead such a cline as we observed was calculated to be in order of 10^{-4} with a certain model. In conclusion,it is doubtful whether the role of natural selection is important in maintaining the clines reported here.If these are mainly due to a migration-drift mechanism,occurrences of similarly unusual geographical clines could be anticipated for some other genetic traits particularly in the Mainland of Japan.

4R-1,3

SUPERNUMERARY CHROMOSOMES IN *DROSOPHILA ALBOMICANS* COLLECTED IN THAILAND. Hatsumi, M. and Kitagawa, O. (Dept. Biol., Tokyo Metropolitan Univ., Tokyo, 158 Japan)

In isofemale lines of *Drosophila albomicans* collected in Chiangmai, Thailand, supernumerary chromosomes (B-chromosomes) were found in their larval ganglion cells. There seem to be no genuine records of their occurrence in any other species of *Drosophila*. All of these supernumeraries were small dot shaped and heterochromatic. Some isofemale lines have the fixed number of supernumeraries, one or two, in an individual. In other lines, however, the number of supernumeraries varied from 1 - 4, maximum six, in different cells of a single individual.

The lines with supernumeraries manifested the low fitness in the egg to adult viability, on an average 55.5%, compared with those of normal karyotype lines, 79.5%.

4R-1,4

STUDIES ON THE COMETITIVE INTERACTIONS IN DROSOPHILA.

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One of the facets of ecological genetics is to study the interactions between populations and the environmental factors. An important component of the population is the presence of other species with which it may compete for the available resources of food and living space. The understanding of the competitive interactions between closely related species and its appreciation is of evolutionary importance. Laboratory populations can be utilised as biological models to study the dynamics and the process of competition. The present experiments were designed to study the impact of competitive interactions in three sympatric species of *Drosophila*, namely, *D. rajasekari*, *D. malerkotliana* and *D. nasuta nasuta*. Both in pure and mixed cultures of these species the following parameters of fitness have been assessed: fecundity, egg to adult rate of development, egg to adult viability, productivity, population size and the overall competitive fitness. The results embody evidences to show that the interspecific competition can have positive, negative and/or neutral effect on the expression of the above mentioned parameters. Thus by considering the overall performance of the three species for the various parameters assessed, the author has suggested the following order of competitive success: *D. rajasekari* > *D. malerkotliana* > *D. nasuta nasuta*. The implications of these findings will be discussed.

4R-1,5

HOUSE FLY POPULATION VARIATION BY PARASITE BIOASSAY AND BEHAVIORAL MEASURES.

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House fly populations were collected from dairy barns at 3 sites - within a 6 km radius - in each of two areas separated by 225 km. The longevity and reproductive capacity of a laboratory strain of the pupal ectoparasite *Nasonia vitripennis* (Hymenoptera; Chalcidae) were used as a bioassay for the 1st and 2nd laboratory reared generations of the 6 house fly strains. The 1st generation analyses utilized wasps reared on the blow fly, *Phaenicia sericata* to provide experimental animals with similar developmental and nutritional histories. The 2nd round of experiments involved parasites reared on their respective host strain to permit analysis of variation in the hosts' nutritional qualities as it affects the wasps' longevity and reproductive capacity. Life table procedures involved supplying a female wasp (with male) with 10- 2.5mm dia., 24-36 hr old pupae plus a droplet of 50% honey solution daily throughout their life. All host strains were tested concurrently with 25 replicates each. Results of the 1st generation life table analyses showed a 3-4 fold variation in the parasites' reproductive output both within and between collection localities. Hosts from one collecting area showed between site variation in parasite R_0 values to range from 39.1 to 149.3 and longevity to range from 6.1 to 7.1 days following adult emergence. Host populations collected from the 2nd area showed generally less variation with female progeny production ranging from 21.2 to 86.0 and very little difference in longevity. Second generation experiments showed a considerable reduction in parasite reproduction with a low mean value of 8 female progeny per reproductive female and as much as 84% of the sample failing to reproduce. The activity and circadian rhythms of these house fly populations were examined with recording activity monitors and demonstrated a 2 fold variation and strain specificity in their patterns of activity.

4R-2,6

ECOLOGY OF *GONIOZUS* SP. (HYMENOPTERA:BETHYLIDAE), ECTOPARASITIC ON THE LARVAE OF *EPIPHYAS POSTVITTANA* (LEP.:TORTRICIDAE).

Danthanarayana,W.,Zoology Dept.,La Trobe Univ.,Vic.,Aust.,3083.

Host-parasitoid relationships of the light brown apple moth, *Epiphyas postvittana* (Walker) (Tortricidae) and its larval ectoparasite, *Goniozus* sp. (Hymenoptera: Bethylidae) were studied for 16 generations in an apple orchard and for 10 generations in a pear orchard in Victoria, close to Melbourne, between 1971 and 1977. *Goniozus* sp. is arrhenotokous and parthenogenetic with unmated females producing males. It is a multiple parasitoid laying 1-7 eggs per host larva in the field, with a mean of 1.8. Parasitism is restricted to caterpillar instars III-VI with instar IV being predominantly parasitized. *E. postvittana* is polyphagous, occurring both on fruit trees and on dicolyledenous weed hosts in the undergrowth. *Goniozus* occurred under both these situations with the occurrence related to the presence of the host larvae rather than to any association with the flora or the microclimate. In general the degree of parasitism between host generations ranged from 0-6.7%. The impact of *Goniozus* as a mortality factor of *E. postvittana* which was studied by k-factor analysis was insignificant. It was evident that the host-parasitoid relationship is of the delayed density dependent type, at both sites. The possibility of using *Goniozus* sp. for augmentative and/or inundative biological control of *E. postvittana* is discussed in the light of the work reported.

4R-2,7 AVOIDANCE OF EXCESSIVE OVIPOSITION IN LEAVES BY FEMALES OF THE RANUNCULUS LEAF MINING FLY, *PHYTOMYZA RANUNCULI SCHRANK*.

Sugimoto, T (Ent. Lab., Kinki Univ., Higashi-Osaka, 577 Japan)

Larvae of *P. ranunculi* live during their development in the limited space of the inner part of a single leaf. It is hazardous to the development and survival of their progeny if flies lay excessive number of eggs with respect to leaf size. We formulated two models of the spatial distribution of eggs in leaves. Each model incorporates submodels in several important stages of both the processes of visiting leaves and subsequent oviposition by the fly. Model 2 is more general than model 1 because of inclusion of the effect of oviposition restraint by the fly in heavily exploited leaves. This paper discusses by use of these models the fact that this fly tends to effectively avoid excessive oviposition in leaves by visiting leaves more sparsely and laying fewer eggs per visit and also by refraining from further oviposition on leaves exploited heavily by mature larvae.

4R-2,8 HOST EXPROITATION BY *PTEROMALUS PUPARUM*, A GREGARIOUS ENDOPARASITOID OF THE PUPA OF *PAPILIO XUTHUS*.

Masami, Takagi (Inst. Biol. Control, Fac. Agr., Kyushu Univ., Fukuoka, 812 Japan)

In order to determine whether *Pteromalus puparum*, a gregarious endoparasitoid of the pupa of *Papilio xuthus*, exploits its hosts of various sizes efficiently, the relations between the number of the parasitoid progenies per host and size, longevity, fecundity and total biomass of their female emergents were examined in the laboratory. From the result of the examination, the most efficient number of the parasitoid progenies per unit weight of the host was estimated. Direct observations on ovipositing parasitoid females and dissection of their ovaries after their oviposition showed that they adjusted the number of their eggs deposited by a single attack to the host capasity so as to achieve such an optimum efficiency. This efficient host exproitation was observed in a field population of the parasitoid except for its unusual high density.

4R-2,9 A SEX RATIO THEORY FOR GREGARIOUS PARASITOIDS.

Suzuki, Y.(Fac. Agr.,Kyushu Univ., Fukuoka, 812, Japan) and Iwasa, Y.(Dep. Biophisics, Kyoto Univ., Kyoto 606, Japan)

Hamilton ('67) explained female-biased sex ratios observed in gregarious hymenopterous parasitoids by local mate competition. It is also known that progeny sex ratios of the parasitoids greatly vary with host/parasitoid ratio. One of the causes is the difference in the progeny sex ratios laid by a female between parasitized and healthy hosts. To explain this phenomenon we considered non-cooperative game among females concerning the maxmization of their own inclusive fitness. Equilibrium progeny sex ratios laid in parasitized and healthy hosts are expressed by the probability of double parasitism (p), the ratio of resource consumption of a male progeny to that of a female progeny (α), the ratio in the cluch size between two females attacking the same host (β), the ratio in the progeny survivorship between double and single parasitism (γ), and the coefficient of inbreeding (f). Our model supplies the explanation for 1) the deviation of Hamilton's simulation results from his theory; 2)the data showing that the percentage male progeny laid by females attacking parasitized hosts increases dratistically as decreases; 3) the occurrence of more than 25% males in doubly parasitized hosts.

4R-3,10 FORAGING STRATEGY OF THE PAPER WASP POLISTES JADWIGAE IN A PATCHY ENVIRONMENT.

Hirose, Y., Takagi, M. and Yamasaki, M. (Inst. Biol. Control, Fac. Agr., Kyushu Univ., Fukuoka, 812 Japan)

The paper wasp Polistes jadwigae forages in a wide area where prey-harboring groves are patchily distributed. In order to detect the foraging pattern of this predator in such a patchy environment, field observations on its foraging behavior were made at a patch containing Papilio xuthus larvae which were artificially placed on a small citrus grove as prey for wasps from natural colonies. Once the wasps hunted the prey, they repeatedly visited the patch over three consecutive days. Time spent searching for prey at each visit was much longer in such experienced wasps than in inexperienced wasps, but the experienced wasps reduced the number of visits per day according to days after the last prey capture in the patch. It is suggested that these behavioral patterns of P. jadwigae have an adaptive significance for its foraging in a patchy environment.

4R-3,11 NESTING SUCCESS OF THE SPIDER WASP (EPISYRON ARROGANS).

A. Endo (Dept. Zool. Kyoto Univ., Kyoto, 606 Japan)

In the nesting of female spider wasp, what conditions reduce the mortality of its offspring wasps? The overall developmental mortality in the nests was 54%. The mortality factors were composed of the predation by the miltogrammine "hole searching" fly Metopia sauteri (17.7%) and the ants mainly Tetramorium caespitum (13.3%), the aggravation of soil surrounding the nurse cell (9.7%), and etc. The probability encountering with the flies was higher when the wasp spent more time principally in nest burrowing. The time spent in nest burrowing was restricted by both relative size of prey to the wasp and soil conditions of burrowing site. Therefore, the wasps, which had hunted relatively small sized prey and/or had prefered sandy ground as their burrowing sites, reduced the chance of encountering with the flies. Furthermore, when the fly visited a nest, the wasp frequently abandoned the nest and re-constructed it at other place. The ants' predation was lowest in sandy area. The mortality derived from the aggravation of soil occurred particularly in sandy and pebblish areas. The wasps having large sized prey must be able to nest effectively and successfully only in sandy area. They, however, having small sized prey seem to nest sufficiently safely even in pebblish area.

4R-3,13 ASPECTS OF THE INTERACTION BETWEEN THE LYCAENID BUTTERFLY, *JALMENUS EVAGORAS*, AND ITS ATTENDANT ANT, *IRIDOMYRMEX* SP.

Kitching, R. L. and Pierce, N. (Griffith University, Nathan, Qld, Australia 4111 and Mus. Comp. Zool., Harvard University, Cambridge, Mass., U.S.A. respectively).

The lycaenid, *Jalmenus evagoras*, has an obligate relationship with its attendant ants, species of *Iridomyrmex*. Aspects of the interactions between the butterfly and the ant, and between the butterfly and its host-plant, species of *Acacia*, will be discussed.

The larvae possess special organs on their abdominal segments and the ultrastructure and gross anatomy of these will be compared with those possessed by other myrmecophilous lycaenid larvae. The role of these organs will be discussed in light of recent exclusion experiments.

The effects on the survivorship and rates of development of the larvae of the presence and absence of ants as elucidated in both laboratory and field will be presented and the ecological consequences discussed. The complicating factor of the age of the food-plant and possible allelochemical influences will be introduced based on the results of field experiments.

The complex symbiotic system will be compared with that known for other species of lycaenid and with the rather better known ant-Homoptera interaction. The possible evolutionary pathways involved in the variety of known ant-lycaenid interactions will be discussed.

4R-4,14 HOST PLANT SUCCESSION OF SHARPSHOOTERS THAT TRANSMIT PIERCE'S DISEASE.

Adlerz, W. C., Univ. Florida, Box 388, Leesburg, FL 32748. USA.

Oncometopia nigricans and Homalodisca coagulata overwinter as adults on perennial plants. Adults move to spring host plants including cultivated grape before Pierce's disease bacteria can be acquired from naturally infected plants. There are two generations, with a second dispersal between spring and summer hosts.

4R-4,15 SCALE COCCUS PSEUDOMAGNOLIARUM KUW. (COCCOIDEA, COCCIDAE) ON CITRUS TREES - THE NEW PEST IN YUGOSLAVIA - BIOECOLOGICAL STUDY.

Mr. Velizar Velimirovic (Poljoprivredni institut Titograd-Yugoslavia)

The scale Coccus pseudomagnoliarum Kuwana has been found on citrus cultures in the Littoral part of Yugoslavia, but it has not been perceived until recently in Yugoslavia.

C. pseudomagnoliarum is an economically important problem on different citrus varieties. In our conditions this variety has one generation each year. It spends the winter in the larval stage after the second change, usually on leaves and young, one year old twigs, as well as older branches having less than 2 cm. in diameter. Females become usually adult in May, and they lay a great number of eggs until July. Young larvae are found on young leaves and outshots and they nourish on them.

Males were also found, but only in a very small number.

In natural conditions many scales perrish, especially in the younger larval stages due to the influence of different abiotic and biotic factors. An important role in reduction of the scale population have parasites. Also predators Exochomus quadripostulatus L. and Chilocorus bipustulatus L. have influence on reduction of the number of scales. In the last few years the population of scales was reduced significantly by pathogenic fungus Cephalosporium lecanii, namely up to 90%.

*Preliminary report

4R-4,16 The Relationship of the Natural Environment and the Population of Dacus dorsalis in Taiwan (Tang, Chin Chuyan, Chiayi Expt. Sta. TARI, Chiayi 600, Taiwan, Republic of China).

This observation was carried out in a subtropical area of Taiwan for 3 years (1977-1979). Traps with poisoned methyl eugenol were used. In this subtropical area, there were 40 years old fruit trees with Sapodilla-Apple, wax-Apple and Madow-Pummelo orchards; the environment was dark and moist. Another area was with 10 years old trees, such as Passion fruits, Citrus and Guava orchards; of which was sunshine and bright. The oriental fruit flies prefer to stay in the environment of dark and moist, except when the fruits were getting ripe. Also the bamboo orchards were the favorite environment for these flies.

4R-4,17 SPECIES OF THRIPS (THYSANOPTERA) CAUGHT IN TEA FIELD AND THEIR SEASONAL PREVALENCE.

Okada, T. (Pest Control Laboratory, National Research Institute of Tea, Shizuoka, 428 Japan) and Kudo, I. (Seiko-Gakuin High School, Shizuoka, 422 Japan)

A much larger number of adults of *Scirtothrips dorsalis* were caught by a sticky suction trap set in a tea field from June to September in a year. Eighty-two percent of all thrips caught during this period was *Scirtothrips dorsalis* which is one of the most serious pests of tea, mandarin orange, grape and japanese persimmon in Japan. *Thrips hawaiiensis* and *Thrips flavus* were caught all the year round. Males of the two species above-mentioned and *Thrips coloratus* are relatively similar to *Scirtothrips dorsalis* in color and size. About twenty-five species were newly recorded by this one year study performed in 1979, while eight species of thrips have been reported from tea bushes until now in Lapan.

4R-5,18 LONG DISTANCE MIGRATION OF BROWN PLANTHOPPER IN THE PHILIPPINES,

Saxena, R. C. and Justo, H. D. (Dept. Ent., Int. Rice Res. Inst., Box 933, Manila, Philippines)

Migrating insects were caught on two successive interisland voyages aboard Escaño Lines Cargo-passenger ships MV SURIGAO and MV AGUSTINA II in the territorial water of the Philippine Archipelago during 1979 wet season, which is characterized by the Southwest Monsoon from the Indian Ocean. The brown planthopper, *Nilaparvata lugens* (Stål), the whitebacked planthopper, *Sogatella furcifera* (Horvath), and other rice hoppers were mostly caught on the Manila-Cebu, and Cebu-Manila routes, which lie in the path of the Southwest Monsoon - a warm and very moist air mass that flows constantly towards the Philippine island during the wet season. These air currents are ideal for transporting insects over long distances. Thus migrant hoppers and other small insects may be carried to the Philippine Archipelago by air currents from certain rice-growing areas lying to the southwest of the Philippines. Exploratory voyages for monitoring migrant hoppers during other seasons and on new routes are being planned.

4R-5,19 FOODWEB OF THE RICE BROWN PLANTHOPPER (*NILAPARVATA LUGENS*) IN THE PHILIPPINES.

Barrion, A.T. and Litsinger, J.A. (Dept. Ent., IRRI, P.O. Box 933, Manila, Philippines)

Predator-parasite relationships were determined for the rice brown planthopper *Nilaparvata lugens* (BPH) from 1977-79 in 4 Philippine provinces representing dryland, rainfed wetland, and irrigated wetland environments. A total of 74 taxa played a role in the good web of BPH. Predatory species outnumbered parasites directly feeding on BPH. 48% of the predator species were spiders (31 taxa in 10 families). Other predators attacking the nymphs and adults were Heteroptera (12), Coleoptera (5), Odonata (2), Orthoptera (1), Diptera (1), Strepsiptera (1), Hymenoptera (5), Acarina (1), and Nematoda (2). Five egg parasites (Mymaridae and Trichogrammatidae) and 1 egg predator (Miridae) were recorded. Surprisingly few secondary natural enemy records were made. Dryinids were parasitized by 4 species of wasps (Ceraphromidae, Encrytidae, Pteromalidae) and 4 species attacked spider egg masses (Scelionidae, ichneumonidae, Tachinidae).

4R-5,20 POPULATION DYNAMICS AND OUTBREAKS OF THE BROWN PLANTHOPPER *NILAPARVATA LUGENS* (STÅL) IN THE TROPICS.

Kenmore, P. E., Dyck, V. A. and Cariño, F. O. (Dept. Ent., Int. Rice Res. Inst., Box 933, Manila, Philippines)

Recent outbreaks of the brown planthopper (BPH) in the tropics have been attributed to the agronomic practices associated with high levels of rice production (Dyck et al, 1979). But crops susceptible to BPH and grown according to recommended wetland practices except for application of insecticides rarely suffer from a BPH outbreak.

Frequent sampling with a new suction sampler called FARMCOP showed that survival of BPH was low, the average survival from the egg through nymphal stage being less than 10%. Reproduction did not appear to compensate for such death rates so the populations naturally declined, evidently due to predation and parasitism.

Other than high levels of immigration which may overwhelm natural enemy action, improper use of insecticides could initiate outbreaks. Even at low dosages certain insecticides cause BPH increase. In an untreated field the BPH population remained small and survival was very low compared with that in a treated (decamethrin) field which ultimately suffered severe crop loss. The decrease in abundance of some natural enemies because of sprayed insecticides must have been a major cause of the increase in BPH survival and hence of the pest population explosion.

4R-5,21 GEOGRAPHIC TREND IN POPULATION FLUCTUATION OF GREEN RICE LEAFHOPPER (NEPHOTETTIX CINCTICEPS).

Kidokoro,T.(Miyagi Pref.Agri.Res.Center,Miyagi, 981-12 Japan)

The population density of the green rice leafhopper tends to be more stabilized in the southern parts than in the northern parts of Japan, as has been pointed out by several authors. In order to clarify this geographic trend in fluctuation of the population density, light-trap records were analyzed. As a result, it was found that the magnitude of fluctuation in the number of adults caught by trap increased from south to north. The annual mean number of catches also increases from south to north, but there is a sharp decline near the northern limit of distribution. This trend supports the assertion that the population density of a species in the central part of its distribution range is relatively stable because of density-dependent processes, while it changes greatly and escape from the regulation mechanism sometimes occurs in the peripheral habitat.

4R-6,22 LARVAL AGGREGATION IN THE EUROPEAN PINE SAWFLY (NEODIPRION SERTIFER).

Nakamura, Hiroshi (Joto Junr. Coll. Kagawa, 767 Japan)

Larvae of the European pine sawfly live in a compact aggregation throughout their larval period. Larvae were reared in the different sizes of groups to examine the aggregation effects on the larval mortality and their aggregational behavior was observed under the national conditions. Mortality rate in the rearings became higher with decrease of the group size but larvae in the rearing groups of more than 10 larvae hardly died. It was observed that several larvae fed together on one needle of the red pine and many larvae formed the tight aggregation on the lower part of needle at moulting time.
It was found that their aggregation involved two types, i.e.,"feeding group" which was composed of several larvae per needle at feeding time and "moulting group" which was formed by many larvae at moulting time.

4R-6,23 LARVAL AGGREGATION OF NORDMANIANA TRACHYDELTA MEYRICK (LEPIDOPTERA : YPONOMEUTIDAE).

Morimoto, N. and Masuzawa, T.(Lab. Appl. Ent., Shinshu Univ., Nagano Pref. 396 Japan)

The larvae of N. trachydelta form a dense aggregation and live in a nest web throughout larval life. And the compact aggregation is still observed in pupal stage.

The effect of aggregation on survival and development of larvae was investigated by laboratory and field experiments. And larval behaviour on the formation and maintenance of aggregation was observed. When younger larvae were reared singly or in a small aggregation, ill effect occurred in survival and development. In field experiment, the survival and the development were suppressed in a small aggregation. These effects of aggregation may be due to the larval behaviour.

Silk trail and nest web make the larvae to establish the feeding site and the larvae tend to keep the mutual contact in an aggregation.

Qualitative difference among individuals could not find , .however, some larvae may certainly play a role of leader in an aggregation.

The ecological importance of the larval behaviour will be discussed.

4R-6,24 THE INFLUENCE OF FLIGHT ACTIVITY ON THE OVIPOSITION IN THE CUPREOUS CHAFER, ANOMALA CUPREA HOPE (COLEOPTERA: SCARABAEIDAE).

Nishigaki,J. (Lab.Appl.Ent.,Fac.Agr.,Shizuoka Univ.,Shizuoka, 422 Japan)

The cupreous chafer, both adult and larva, is a serious crop pest in Japan. The adults, which appear in summer, usually fly about in every night through whole of their life time. To find the ecological meaning of flight activity in their life history, following experiments were carried out. Newly emerged adults were divided into two groups, the flight and the non-flight, and both of them were kept in the same laboratory condition to the end of their life span. For the flight group tethered flight was made in every day, while any kind of flight was prevented for the non-flight group. Through the experiments, there was no significant difference between these two groups on daily change of food consumption per individual and that of mating frequency. Also total number of eggs laid per female of the both groups were so similar, but the most active period of oviposition in the flight group was earlier than in the non-flight group in their adult life span. Thus, it is concluded that the flight activity can accelerate the ovary maturation or oviposition, and may lead to elude the reproductive reduction due to the high mortality in the later adult life in their natural population.

4R-6,25 OBLIGATORY NOMADISM IN CHRYSOPA CARNEA: A DISPERSAL STRATEGY FOR UNPREDICTABLY CHANGING HABITATS.

Duelli, P., Hagen, K.S. (Dept.Ent., Div.Biol.Control, UC Berkeley, Calif. 94706 USA)

The take-off response and landing stimuli involved in dispersal flights of the green lacewing, Chrysopa carnea Steph., have been investigated in Californian alfalfa fields and in laboratory experiments. Take-off behavior is triggered by the decrease of illumination after sunset. It is not influenced by air movements carrying the scent of honeydew "attractants" nor by the presence of various food stimuli on the plants. In the first two nights after emergence the lacewings perform straight downwind "adaptive dispersal flights" on which they do not react to kairomones signaling food. In the first two nights both fed and unfed females are able to fly a nightly average of four hours on a flight mill. By the third night, the lacewings begin to react to the scent of honeydew which now acts as a strong landing stimulus on the lacewings' "appetitive downwind flights". After landing, the food source is approached in a low, stepwise anemochemotactic flight within the scent plume.

The first insemination of females is possible 3-4 days after emergence. The first eggs may be laid on the fifth day (at 25°C). Therefore, even during a period of windless nights a female with a flight speed of only 0.75m/sec is very likely to leave the field where she originated and migrate several kilometers prior to mating and oviposition.

It is speculated that the strategy of obligatory preovipositional migration allows Chrysopa carnea to thrive in agricultural environments where changes in the quality of the habitat are often drastic and unpredictable.

4R-6,26 DIRECTION OF INSECT MIGRATIONS IN RELATION TO THE WIND. Mikkola, K. (Zool. Mus., Univ. Helsinki, SF-00100 Helsinki 10, Finland)

Recent advances in research on insect migration have shown that the direction of many flights is based on compass orientation (Baker, 1978). Meanwhile, too little attention has been paid to the role of wind as a factor determining the direction. Most immigrant Lepidoptera arrive in Finland with warm S - SE air currents, mainly from the Russian steppe area. Wasps (*Vespula*), bumble bees (*Bombus*) and dragonflies (Odonata) often migrate at the same time upwind, i.e. in the opposite direction. Upwind orientation requires visual contact with the ground or water surface: the same insects may migrate downwind at a higher level but return upwind close to the surface, as observed in Syrphids.

4R-7,28 THE DYNAMICS OF EPIDEMIC SUGARCANE CICADA POPULATIONS. Nagamine, M. and Itô, Y. (Okinawa Prefectural Agricultural Experiment Station, Naha 903, Japan)

The population density of a cicada, *Mogannia minuta*, reached an extraordinary high level in sugarcane fields of Okinawa since 1960's. Prolonged outbreak and unique feature of the microdistribution suggested that the epidemic population had escaped from predation pressure. Life tables showed that the critical stage lies from egg-hatch to establishment of 1st instar nymphs to sugarcane rhizome and the key-factor is predation by ants. The intrinsic rate of increase was higher in sugarcane fields than in *Miscanthus*-grasslands, the original habitat of this species. Repeated ratooning of the sugarcane and decrease of natural enemies due to continued application of chrolinated insecticides should be the factor which induced the initial increase of cicadas and, once the population reached an epidemic level, improved intrinsic rate of increase and the escape from predators could attribute the maintainance of the epidemic status. The density in the *Miscanthus* grasslands, where the intrinsic rate of increase was negative, is high during recent years, but this is considrred to be due to immigration of cicadas from sugarcane fields.

4R-7,29

POPULATION DYNAMICS OF BURNET MOTH (PRYERIA SINICA) AND THE ROLE OF ICHNEUMONID PARASITE (AGROTHEREUTES MINOUSUBAE) AFFECTING IT. Shiotsu Y. and Tsubaki Y.(Dept.Biol.,Kyushu Univ.)

Population dynamics of the burnet moth, Pryeria sinica was investigated by analizing life tables obtained at five different places in the suburb of Fukuoka city from 1976 to 1979. The number of eggs layed by a female moth was estimated ca.130. The egg and larval mortality were low and about 45% of individuals survived to middle of the final (4th) instar. No or little difference was found in survival of egg, 1st and 4th instar among places and among generations. The mortality in cocoon stage was different not only among places but among generations and it ranges widely as 8-98%. The key factor in cocoon stage was parasitism by Agrothereutes minousubae. The mortality caused by the parasite was assumed as the delayed density dependent phenomenon within a place, while that was direct density dependent manner among five places. The latter case indicates that the parasite acts as the stabilizing factor on the population dynamics of the burnet moth.

4R-7,30

LIFE TABLE ANALYSIS OF THE MOSQUITO, *CULEX TRITAENIORHYNCHUS SUMMOROSUS*.
Chubachi, R. (Dept. Biol., Fac. Educ., Tokushima Univ., Tokushima, 770 Japan)

Generation-mean life tables* of which parameters are given as mean values for all generations existing during a mean generation time, are constructed using data on seasonal population changes of *Culex tritaeniorhynchus summorosus* in 14 ha paddy fields. The mean generation time is estimated by temperature summation, assuming that the ratio of l_x (probability of surviving to the xth oviposition) to l_1 and that of m_x (mean number of female eggs laid by one female at the xth oviposition) to m_1 are constant over the whole breeding season. The thermal constant and the developmental zero are 277.8 day-degrees and 10.1 °C respectively. The population growth rate per generation and the survival rate of larvae and pupae are estimated directly from their census data. The proportion of females is regarded as constant. Employing these parameters, the expected fecundity (total number of eggs which one female is expected to lay during her complete life-time) is calculated on the assumption of a constant survival rate of eggs and of equality between emigration and immigration.

Analysis of the life tables shows that the mortality of larvae and pupae due to factors other than the drainage of paddy fields is the key factor causing population change and dependent on larval density. The reduction of natality including variations in adult mortality, fecundity, migration and egg mortality is also shown to be dependent on larval density. The most important regulatory mechanism may be intraspecific competition among larvae and seems to be closely related to the spatial structure of the larval population. There are two distinct equilibrium levels indicated by larval density. The first equilibrium level is higher than the second, and such a change is caused mainly by the increase of larval and pupal mortality due to the drainage of paddy fields.

*Proposed for populations with incompletely overlapping generations (Chubachi, R. *J. Anim. Ecol.* 48, 681-702 (1979)).

4R-8,31

POPULATION EQUILIBRIA : FACT OR FANTASY? Dempster, J.P. and Pollard, E. (Monks Wood Exptl. Stn., Huntingdon, England)

There is an extensive literature in theoretical ecology in which population models have been developed from the basic concept of stable equilibria, maintained by the action of density dependent processes (cf. May, 1976). This concept has been developed from the logistic equation, but its validity is questionable (Pollard, in press). In our opinion, a more realistic population model is obtained from the original idea of the logistic equation, i.e., in which population growth is limited by the 'ceiling' set by the carrying capacity of the environment. In this paper, the evidence for and against the concept of population equilibria is discussed in light of recent field studies of insect populations.

4R-8,32 STABILIZATION OF POPULATION BY PARASITIC COMPETITOR. Yamamura,N.(Dep.Nat.Sci.,Saga Medical School,Saga 840-01 Japan)

When there exist two species such that the two compete with each other and that one (species A) is parasitic on the other (species B), A is called a "parasitic competitor" with respect to B. "Parasitic" here means that A cannot increase without B. Conditions for stability of both populations are then derived. The relation thus defined is further shown to be mathematically equivalent to the Host-Parasite relation wherein there is a possibility of survival for attacked host individuals.

4R-8,33 QUALITATIVE ANALYSIS OF NONPARAMETRIC MODELS OF THE FOREST INSECT NUMBER DYNAMICS.

Isaev A.S., Khlebopros R.G., Nedorezov L.V. (Inst. Forest and Wood Sib. Br. USSR Ac. Sci., Krasnoyarsk, 660036, USSR)

The forest insect number dynamics is considered according to the principle of the dynamic ecological system stability (Isaev, Khlebopros, 1973, 1978). Inertial and noninertial regulating factors of the system are shown to lead to qualitative differences in the number dynamics of separate groups of forest insects, these differences depending on the relative contribution of each factor to the regulation. The typical points of the system and individual estimation of regulating factors according to a degree of their inertiality have been used to construct the population phase portrait. Analysing its structure one can establish qualitative and quantitative parameters of the insect number dynamics, elucidate a nature and significance of individual regulating factors, and define conditions under which a species will be able to develop an outbreak. The structural characteristic of the population phase portraits has been used to classify the types of the forest insect number dynamics.

4R-9,34 DIVERSITY OF INSECT COMMUNITIES IN LEAF-MINES AND PLANT GALLS. Askew,R.R.(Dept. Zool.,Manchester Univ., Manchester M139PL,England)

Cynipid gall-wasps and Phyllonorycter leaf-miners support rich communities of parasitic Hymenoptera. They include more polyphagous than specific parasite species and they are more diverse on trees than on shrubs or herbs. In the latter situation communities are usually dominated by specific parasites whilst polyphagous parasites achieve their highest representation in tree communities. Polyphagy is favoured in situations of high host variety and this occurs on trees in the cases of both gall-wasps and Phyllonorycter. The varied structure of oak galls provides a basis for partitioning of resources between polyphagous parasites and may explain the co-existence of many cynipid species on oak trees. Polyphagous parasites in Phyllonorycter mines do not, in general, discriminate between primary hosts on the same plant species and numbers of co-existing species of Phyllonorycter are restricted.

4R-9,35

SOME RESULTS OF QUANTITATIVE STUDIES ON HIGH-MOUNTAIN MEADOW ARTHROPODS.

De Zordo,I., Janetschek,H. and Schatz,H. (Zool.Inst., Univ.Innsbruck, A-6020, Austria)

Based on investigations on arthropods from a mountain meadow (2000 m, Central Alps, Tyrol) intensive studies on dominant saprovores (Oribatei; 60% of mesofauna-abundance) and carnivores (Carabidae) were made. Population dynamics of oribatids were observed during 4 years (soil samples). Abundance and biomass of Oromurcia sudetica is significantly higher in winter than in summer; Achipteria coleoptrata has maxima in autumn and spring; Oribella paolii in summer. Due to temperature effect respiration rate of all species is highest in summer. The cumulative value for O.sudetica is 75 ml $O_2/m^2/a$ (= 1525 $J/m^2/a$), A.coleoptrata 19 (391), O.paolii 10 (205). For Pterostichus jurinei (Carabidae) activity (pitfall traps) and absolute densities (mark-recapture) were estimated. Direct correlation of both abundance values is not possible (changing effects of environmental parameters and behaviour over the seasons). Pt.jurinei has a 2-year life cycle with overwintering L III and young imago. Main activity period of imagines is in spring (reproduction). Correlation of trapping efficiency with temperature is significant using the reliable estimates of this season. This result is not valid for other species, sites and seasons.

4R-9,36

SPECIES STRUCTURE OF HETEROPTERA OF NIGERIAN COCOA FARMS.

Nwana, I. E., (Dept. Agric. Biol., Unibadan, Ibadan, NIGERIA)

The species structure of the Heteroptera of a Nigerian Cocoa Farm was adequately described by the log series thus suggesting some similarity with the natural rainforest ecosystem where cocoa normally grows. The closeness of fit between observed and expected species structure was slightly influenced by the method of sampling.

There were marked over-lappings in the 95% fiducial limits of the indices of diversity for the heteropteran population of seven cocoa farms sampled thus showing considerable similarity in the structure of the heteropteran fauna of Nigerian cocoa farms.

4R-9,40

THE SPATIO-TEMPORAL DISTRIBUTION OF ELEVEN SPECIES OF CARRION BLOW-FLIES NEAR MELBOURNE, AUSTRALIA.

D.PALMER AND I.W.B.THORNTON (Department of Zoology, La Trobe University, Victoria 3083, Australia)

Of eleven carrion blow-fly species (Calliphoridae) in the Melbourne area, the dominant one is *Calliphora stygia*. Most of the others are able to compete successfully with it for brief periods, provided that certain combinations of factors related to season, habitat, carcass size and successional stage obtain.

4R-10,37 PHOTOPERIODIC RESPONSE OF A CERAMBYCID BEETLE (ACALOLEPTA LUXURIOSA BATES), HARMFUL TO ANGELICA TREE: INDUCTION AND TERMINATION OF ITS LARVAL DIAPAUSE.

Honda, K. (Lab. Ent., Fac. Agri., Tokyo Univ. Agri. & Tech., Fuchu, 183 Japan), Akutsu, K. and Arai, S. (Tokyo Agri. Exp. Stn., Tachikawa, 190 Japan)

A cerambycid beetle (Acalolepta luxuriosa Bates) is known as the pest of araliaceous plants, into which it bores and feeds. The larvae pass winter in a diapausing fullgrown stage (Honda et al., 1979).

The photoperiod of 14hr light and 10hr dark (14L-10D) did induce diapause to almost all the larvae, and 8L-16D produced 100 % diapause. In the change of photoperiodic condition from 8L-16D to 14L-10D during the early to mature larva, the later was replacing, the more shortened was the diapausing period, and eventually it disappeared. Thus, the change of daylength to longer photoperiod promoted also the termination of diapause in the diapausing larvae. When the larvae were transferred reciprocally from 14L-10D to 8L-16D at 40 days after hatching, the diapause became much longer and markedly persisted. In this insect, therefore, a decrease and increase in daylength may influence on both the induction and termination of diapause.

4R-10,38 THE LARVAL DIAPAUSE OF THREE SCARABAEID BEETLES AND ITS FUNCTION IN THEIR LIFE CYCLES.

Fujiyama, Shizuo(Dept. Biol., Shinshu Univ., Matsumoto, 390 Japan)

The larval diapause in scarabaeidae has only been found in a few species in the world. I have found the diapause in three species, i.e. *Anomala cuprea, A. rufocuprea* and *Maradera castanea*. The diapause was induced at the end of the larval stage(the yellow larval stage) when the larva was reared at a constant high temperature(20—30°C). In *A. cuprea,* the diapause was averted when the larva was chilled, e.g. at 5°C for 50 days within the period from the end of the second instar to the third instar. In all larvae of *A. rufocuprea* examined the diapause was averted in all the larval stages of hibernation. This also seems to be the case with *M. castanea*. In the field, the majority of larvae do not hibernate in the diapausing stage except for *A. cuprea* in southern Japan but do so in the other larval stages in spite of their univoltine life cycles. Thus, the diapause is latent in these larvae but it prevents untimely adult emergence if the larva matures by the end of autumn. These results suggest that some other scarabaeids and some insects which live in the soil all their life except for the adult stage, might have a similar type of diapause.

4R-10,39 INFLUENCE OF PHOTOPERIOD ON THE ADULT DIFFERENTIATION IN THE PUPAE OF A UNIVOLTINE PAPILIONID, LUEHDORFIA JAPONICA.

Ishii, M. and T. Hidaka (Dept. Zool., Kyoto Univ., Kyoto, 606 Japan)

Luehdorfia japonica has a univoltine life cycle: the adults appear early in the spring and the most period of the year is passed as the "diapausing" pupae. The pupal diapause of this species has long been studied by many workers. Especially, Hidaka et al. (1971) has demonstrated that adult differentiation could proceed only at a "moderate" temperature between 15 and 23°C. Since studies made so far, however, paid little attention to the light conditions, effect of photoperiod on the adult differentiation was examined. The results showed that the onset of the adult differentiation was much retarded under a long-day condition even at a "moderate" temperature, while under a short-day condition, the imaginal differentiation started quickly and the adult formation was completed within about 5 months. The critical photoperiod seems to vary with the photoperiod during larval stage. Adult differentiation once started, it never stops even when the pupae were transferred to a low temperature or a long-day condition. The possibility that the time of adult eclosion is also determined by photoperiod was suggested. Although the pupae of the present species have dark and thick cuticle, a small transparent area is found on the head. But, the function of this area is still unknown.

4P,2 ECOLOGICAL CHARACTERISTICS OF EXOPTERYGOTE INSECTS FROM HABITATS OF DIFFERENT SUCCESSIONAL AGE.

Brown, V.K. and Southwood, T.R.E. (Dept. of Zool. & Applied Entomology, London, U.K.)

Three stages in a secondary succession, typical of that occurring on a sandy soil in Southern England, are represented by a recently harrowed field, an area of permanent mixed grassland with forbs and a predominantly birch woodland. The relationship between the exopterygote insect fauna and the floral composition of the habitat will be described. It has already been demonstrated that plant species diversity rises and falls during succession whilst structural diversity (with both spatial and architectural components) continues to rise (Southwood, Brown and Reader, 1980). The impact of these trends on the diversity and stability of the extensive exopterygote fauna will be discussed. The guild structure of the insects is expressed in terms of the successional age of the habitat.

4P,4 PHASE VARIATION AND DIAPAUSE IN THE LOCUST, *LOCUSTA MIGRATORIA*, IN JAPAN.

Tanaka, H. (Ent. Lab., Col. Agr., Kyoto Univ., Kyoto, 606 Japan)

An extraordinarily famous pest, *Locusta migratoria*, occurs also in Japan from the northern end, Hokkaido, to the southern end, Loochoo islands, but it does not swarm nor cause much damage at least recent 100 years. Only an exception is the occurrence of small scale swarming in a few islands in Loochoo in 1972-74.

Since we have no detailed information on physiology and ecology of this insect, the present investigation is attempted to know whether it shows phase variation as remarkably as in the African subspecies, and how the population is adapted to climatic conditions in Japan.

It has been revealed that in laboratory, Japanese population shows clear phase changes in respect to morphometrics, coloration and behaviour, though phase transformation rarely took place in the field. It is also interesting that there seems to be a large variation in the egg diapause in the population collected in Kyoto.

4P,5 A MIGRATORY SKIPPER PARNARA GUTTATA GUTTATA, ITS ECOLOGY AND PHYSIOLOGY I. ECOLOGICAL ASPECTS OF THE MIGRATION.

Nakasuji, F.(Ent. Lab., Coll. Agr., Kyoto Univ., Sakyo, Kyoto 606, Japan)

The rice plant skipper, Parnara guttata guttata has been observed in regular mass movements to the west or south-west direction in early September in central and western Japan. The skipper has three generations in a year and overwinters as diapausing larva. Adults of overwintering and the first generations emerge in early June and mid-July, respectively. The offspring of these butterflies develop on rice plants or annual summer grasses which grow in wet lands. Adults of the 2nd generation emerge in late August and they migrate. After the migration, females lay eggs on various kinds of biennial and perennial winter grasses in dry lands.

Why they move to the west or south-west is unknown but they seem to migrate not for overwintering but for some other reasons, because the survival rate of larvae during the winter is as high as 50 percent or more even in the regions where the mass movement occurs. They may migrate relatively short distances, perhaps less than 100 km. The skipper has at least two distinct seasonal forms, i.e. summer (1st gen.) and autumn (2nd gen.) forms (see the next abstract). Females of the latter form have higher flight activity, lower fecundity and larger pre-ovipositional period than the former. These characteristics are thought to favour migration. The skipper might be selected for producing the seasonal migrant form due to the obligatory habitat change from wet to dry land grasses in autumn.

4P,6

The Crowding Effects in the Ramie Moth (*Arcte coerulea Guenée*).

Ohtaishi, M. (Pest Control Laboratory, National Research Institute of Tea, Shizuoka, 428 Japan)

The larvae of the ramie moth often deplete food plants, *Boehmeria* spp., at high densities and show the marching habits like the army worms. The larvae showed a remarkable variation in body color depending on the rearing density. Under crowded conditions, the thorax and abdomen of larva conspiciously darkened after third instar, but the head color became black in earlier instars and reddish brown in later instars. This change of head coloration was just opposite to the change in the solitary larvae. Darkened larvae of crowded culture (high-density type) were more active, ate less, and developed more rapidly than pale larvae of isolated culture (low-density type). The former transformed into smaller pupae and the ensuing adults had lower wing loading. The larvae of this insect showed a remarkable oscillatory movement when disturbed, which was considered to be the defence reaction to the attack of natural enemies. This behavior was particularly well developed in the high-density type larvae. In relation to this, it is interesting to note that coloration of high-density type larvae would be regarded as aposematic.

4P,7

WING MORPHISM IN BROWN PLANTHOPPER,

Saxena, R. C., Okech, S. H. and Liquido, N. J. (Dept. Ent., Int. Rice Res. Inst., Box 933, Manila, Philippines)

The changes in the physiological status of the host rice plant had a profound effect on wing morphism in the brown planthopper, *Nilaparvata lugens* (Stål). Significant increases in macroptery in the hopper progenies reared on senescent or 'hopperburned' hosts were probably because of a general decline in the host plant's nutritional status and a change in the level of allelochemic factors. The continued stress of starvation perceived by young nymphs when restricted to feeding on nutritionally-depleted, senescent hosts probably inactivated the corpus allatum, which turned off the secretion of the juvenile hormone (JH). In the absence of JH, brachyptery would be suppressed and macroptery would operate. The host plant's allelochemic factors, on the other hand, would have a direct effect on wing morphism. Green tissues of young plants were rich in allelochemics, while senescent plant were dificient. Any juvenilizing effect of the rice plant allelochemics would therefore dissipate with the plant's senescence. The proportion of the macroptery in the hopper progeny developing on the rice plant would therefore be determined by the extent of nutritional depletion and the decrease in the level of the allelochemic factors. Wing morphism in brown planthopper is thus an expression of insect-plant interaction and represents the insect's adaptation to a changing but nonetheless predictable environment.

4P,8

CUMULATIVE EFFECT OF CROWDING ON THE PRODUCTION OF ALATE FORM IN A ROOT APHID, *RHOPALOSIPHUM RUFIABDOMINARIS* (SASAKI).

Yamaguchi, Y. (Ent. Lab., Coll. Agric., Kyoto Univ., Kyoto 606 Japan)

Rhopalosiphum rufiabdominaris is a host-alternating aphid known as a pest of upland rice. In spring it migrates from cherry or plum to grasses. After colonization of migrants on grasses, their offspring pass through several generations parthenogeneticaly on the roots of the host plants. Appearrance of winged virginoparae in these generations is associated with the increase in population density. Laboratory experiments using rice seedlings showed that this crowding effect operates cumulatively over some generations. The percentage of alatae increased with the number of generations even if virginoparae were reared under the same density condition. For example, when rearing density was five per seedling, the percentages of alatae of 1st, 2nd, 3rd, and 4th generations were about 0, 8, 46, and 90% respectively. The increase in the percentage of alatae was more rapid when reared under any higher densities. Ecological meaning of such an effect is discussed in relations to the resourse utilization and dispersal in *R. rufiabdominaris*.

4P,9 A COMPARISON OF THE REPRODUCTIVE STRATEGIES BETWEEN THE CABBAGE APHID (BREVICORYNE BRASSICAE) AND THE GREEN PEACH APHID (MYZUS PERSICAE).

Hayamizu,E.(Lab.Appl.Ent.& Nemat.,Nagoya Univ., Nagoya,464 Japan)

B.brassicae and M.persicae coexist on the same cruciferous host plant but they have different ecological characters(distribution pattern,life cycle,host range,etc.).Comparative ecological studies were carried out in order to clarify the significance of them,with special reference to distribution patterns.It was found that the nymphs of B.brassicae tended to stay in contact with their mother and to form a contact clustered colony.Although nymphs often changed their positions within a colony, they still remained in a compact aggregation.Mothers rarely changed their positions during larviposition. On the other hand,the new-born nymphs of M.persicae settled at a short distance from their mother. Afterward in the colony,however,their mobility was not so high.The mother moved more frequently than that of B.brassicae.As the colony developed,B.brassicae maintained a compact aggregation,whereas M.persicae tented to disperse and spaced out.When an individual of B.brassicae approached a colony of the same species,it often settled in contact with members of that colony,but M.persicae did not so.

4P,10 RELATIONS BETWEEN FOOD CONDITIONS FOR ADULTS AND ACTIVITIES OF FLIGHT AND OVIPOSITION IN THE BEAN BUG, RIPTORTUS CLAVATUS THUNBERG.

Natsuhara, Y. (Lab. Ent., Coll. Agriculture, Kyoto Univ. Japan)

R. clavatus is an active Coreid, feeding on pods of leguminous plants. The flight and oviposition activities in this species were studied experimentally in relation to the quantity of food for adults. With ample food (10 Azuki bean per pair per two days), the female laid more eggs, but its flight activity as examined by tethered flight technique was notably lower as compared with that whin reared with scarce food (1 bean per pair). A peak of flight activity was observed about 10 days after adult emergence regardless of food conditions. With ample food the activity then falled, but with scatce food it was retained after that and long flight (more than 10 minutes) observed periodically. Ecological implication of these results is discussed with reference to the efficiency of resource utilization in natural populations of this species.

4P,11 THE PHASE VARIATION IN *LIBYTHEA CELTIS* (LEPIDOPTERA:LIBYTHEIDAE)

Akayama, A. (Ent.Lab., Col.Agr., Kyoto Univ., Kyoto, 606 Japan)

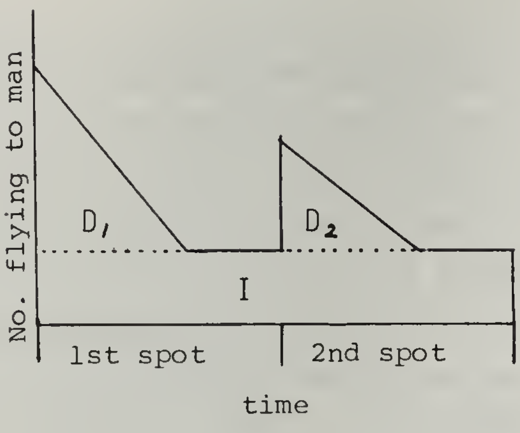
Libythea celtis is distributed widely in Japan and feeds on *Celtis sinensis* (Angiospermae:Ulmaceae). A phenomenon sinilar to phase variation in armyworm was observed in the coloration of the larvae of *L.celtis* when they were reared at different densities under various temperature and light conditions.

The body color shows a remarkable change from green to true black. When larvae are reared in isolation, all the individuals become pale color at the final inster (5-th) stage, and with the increase of density larvae become dark. Larvae reared in crowds develop more rapidly and a little more active than those reared in isolation, and adult butterflies emerged from crowded cultures become smaller than those from isolated cultures. These characters are similar to those of other insects which show phase variation, but the different points are that larval walking ability and tolerance to starvation show no difference between low density type and high density type.

4P,12 ATRACTIVE DISTANCE OF MAN FOR MOSQUITOES.

Nishimura, M. (Dept. Zool., Kyoto Univ., Kyoto, 606 Japan)

When we use some baited trap it is important to know the range of its effective area. Mosquitoes flying to man at a spot in the woods are composed of D: those already in effective area before man arrive there and I: those intruding the area. When we sample at 2 areas continuously, D_2 is less than D_1, because of overlaping 2 effective areas. Assuming that the area is a circle, R: radius of it can be calculated. Comparing D/I and R between species, we can get some aspects of host searching activity of each species.



Species : *Aedes albopictus*
A. japonicus
Tripteroides bambusa

4P,13 A MIGRATORY SKIPPER, PARNARA GUTTATA GUTTATA. II. SEASONAL POLYMORPHISM AND LARVAL DIAPAUSE.

Ishii, M. (Dept. Zool., Kyoto Univ., Kyoto, 606 Japan)

Adult of the rice-plant skipper, Parnara guttata guttata migrate in early autumn. The season, the area and the direction of the migration are known to be restricted. Why/how is it so? In order to get the key for solving this problem, experiments of rearing larvae and pupae under various temperature and photoperiodic conditions were carried out. The result demonstrated the presence of adult seasonal polymorphism and larval diapause. Adult seasonal polymorphism: the adult morphology varied manifoldly with temperature and photoperiodic conditions during larval period. Shorter photoperiod induced darker wing coloration and larger size but independently each other. Temperature exerted threefold effect: lower temperature inducing larger size, stronger melanization and more conspicuous silver spots on wings. It is intriguing that adults of the autumnal migratory generation corresponds to the large- and dark-winged "short-day" form. Larval diapause is induced by a short day and characterized by the retardation of the larval growth and extramolts. The larval duration seems to become longer in proportion to the period exposed to a short day after hatching. A long day terminates the diapause, but cooling of diapausing larvae seems not to be effective for the diapause termination.

4P,14 MALES' SITE SELECTION PROCESS AND MATING SUCCESS IN A DAMSELFLY, CERCION CALAMORUM.

Ueda, T. (Dept. Zool. Kyoto Univ., Kyoto, 606 Japan)

Males of the damselfly, Cercion calamorum, wait for females to mate at pond and the surrounding area. Therefore, it is very important where males wait for females relating to the males' mating success. Site suitability for mating should be assessed originally by the probability of encounter with female, but males actually seems to perceive it by the suitability for oviposition. Ideal free distribution of males (all males experience equal female quotas) was modified by limiting mobility and male-male interactions. Residentiality of males restricted the searching range for site selection. Males could not always choose the most suitable site. Aggressive interactions among males had a buffer effect on density increase at the suitable site and produced many floaters, which crowded out to the surrounding area. The surrounding areas were less suitable for oviposition and mating; but the floaters sometimes intercepted and copulated with females before they arrived at the suitable sites. Therefore, increasing of such floaters raised the rate of interception and reduced the mating rate of themales even at the suitable sites.

4P,15 AN ANALYTIAL STUDY OF THE TERRITORIAL SYSTEM OF MNAIS PRUINOSA PRUINOSA (ODONATA; CALOPTERYGIDAE).

HIGASHI K., NOMAKUCHI S., MAEDA M., HARADA M. AND ŌKAME Y. (DEPT. BIOL., KYUSYU UNIV., FUKUOKA 812, JAPAN)

The emergence of this dragonfly was seen at a mountain stream in the suberb of Fukuoka City, Kyushu, from late of April to early of May. It is considered from the short period of emergence that this species belongs to the " spring type " (Corbet, 1954). We simulated the territorial system of this dragonfly through the reproductive period, and discussed the influence of the synchronization of emergence to the occupancy and maintenance of the trritory and residentiality. In the simulation, we considered the following four stage; 1) emergence curve, 2) teneral period, 3) arrival at the stream, and 4) occupancy of the territory.

4P,16 RESPONSES TO STARVATION IN A MANTIS, PARATENODERA ANGUSTIPENNIS (S.).

Matsura,T. (Dept. Zool., Kyoto Kyoiku Univ., Kyoto,612 Japan)

Arthoropod predators in the field are often exposed to starvation. Responses to starvation in predators have been clarified by using spiders (Miyashita 1968, Anderson 1974), but studies about pedatory insects are few. Using a mantis, Paratenodera angustipennis, survival period, pattern of decrement of the body weight and respiration rate under starvation were examined.

The tolerance to starvation became stronger as the larvae developed. Mean survival periods of adult males and females were 15.0 and 26.7 days, respectively. Body weight greatly decreased during the first 5 days (adults) due to ingestion of food remaining in the gut and then it decreased slowly. As for the respiration rate, it decreased with an increase in the fasting period.

As compared with spiders, the mantis seems to have a weaker tolerance to starvation.

4P,17 EFFECTS OF STARVATION ON THE METABOLIC RATE OF A WOLF SPIDER(*PARDOSA ASTRIGERA*)

Tanaka,K。 (Lab. Appl。 Ent。& Nemat。,Nagoya Univ。,Nagoya, 464 Japan)

A study was carried out to clarify the effects of starvation on the metabolic rate of a wolf spider *Pardosa astrigera*, common hunting spider living in grassland in Japan. Adult spiders were well fed on the green rice leafhopper adults for ten to twenty days after the final moult, and then supplied no food but water. Laboratory condition was maintained at 25°C and 16L8D。 CO_2 outputs and live body weights were measured every sixth days。 The mean survival times under starvation were 28。80±2.68 days in males and 54.40±18.88 days in females. Metabolic rate decreased to 55% in males and to 64% in females during the first twelve days of starvation, and thereafter stabilized。 Body weight decreased at a constant rate during starved period。 The percentage reduction ampunted to about 20%。 When the starved individuals were fed for five days, metabolic rate and body weight almost recovered。

4P,18

LIFE-HISTORY OF THE PREDATOR *CHRYSOPA CARNEA* STEPHENS IN IRAQ. AL-Rubeae,J. and Ibid,M.K.(Plant protection Dept.College of Agriculture,Baghdad Univ.,Abu-Ghrab,Baghdad,Iraq)

The biological processes of this predator weres studied at 25±I and 60-70% R.H.The incubation period ranged between 3and 4 days with an average of 3.97,The percentage of hatching 85.5%,the duration averged 6.30,4.20 and I4.20 respectively for the first ,second and third larval fed on Mealy bug *Nipaecoccus vastator* and 3.0,3.8 and II.0 days for those fed those on Aphids *Myzus persicae*.The ave--age consumption for the first ,second and third larval instars of the predatore were 2540,26I6.5 and 5697.5 egg of *N. vastator*,264.9,264 and 330.5 nymphs of *M.persicae* the prepupal period averged 3.0 days on Mealy bug and 2.3 days after feeding on aphids.The pupal period averaged II.5 days ,the preovipostion period averaged 5.47 days ,oviposition period 4I.5 days.The female deposited 378 egg with adaily rate of 27 egg.Life span of femal was 52 days and of the male was I8.6 in averge,sex ratio was nearly I:I.Egg parasite belong to genus *Telenomus*(Sclelionidae) and larval-pupal parasite belong to genus *Dichrogaster* (Ichneumonidae) were observed.

4P,19

BEHAVIORAL RESPONSE OF APHIDOPHAGOUS INSECTS TO THE PREY DISTRIBUTION WITH SPECIAL REFERENCE TO QUADRAT SIZE. Sakuratani,Y.(Ent. Lab., Coll. Agr., Kyoto Univ., Kyoto, 606 Japan)

The behavioral response of natural enemies to the prey distribution is an important element in evaluating the role of natural enemies. But the value of the index describing the characteristics of the joint distribution may be influenced by the quadrat size. In this study, the response of aphidophagous insects to the aphids on corn plants was analyzed using three different sampling units: leaf, plant and plot(a group of several plants) based on the interspecies mean crowding (Lloyd,1967), the index of overlapping (γ)(Iwao,1977) and the degree of spatial correlation (ω)(Iwao,l.c.). In many coccinellids, some syrphids and a cecidomyid, the degree of overlapping with aphid populations was relatively low when a leaf or a plant was used as the sampling unit, but high when a plot was used as the unit. Thus these natural enemies may respond to the density of aphids over a group of several plants rather than that on a leaf or a plant.

4P,20

THE IMPORTANCE OF SPATIO-TEMPORAL COINCIDENCE IN HOST-PARASITE INTERACTION BETWEEN THE ORIENTAL MOTH, *MONEMA FLAVESCENS* AND A CHRYSIDID WASP, *CHRYSIS SHANGHAIENSIS*. Yamada,Y. (Ent. Lab., Col.Agr., Kyoto Univ., Kyoto, 606 Japan)

The degree of coincidence in space and time plays a very important part in the dynamics of host-parasite interaction between the oriental moth and *C. shanghaiensis*.

The larva of this moth is protected by stinging spines and its cocoon is fixed to the twig, branch, or trunk of a tree. *C. shanghaiensis*, a cocoon parasite specific to this moth, is said to have been introduced into Japan about 70 years ago and spread over wide areas after World War II, and it seems to have reduced its host population to a very low level. Both the moth and the parasite have one or two generations a year near the study areas in Kyoto. In the first generation, spatial and temporal coincidence between both species was almost perfect, so that the percentage parasitism was high (50-80%) in each patch in 1978 and 1979. In the second generation, the host cocoons which were spun later and near the ground (few first-generation cocoons were found in such a place) were less liable to be attacked by the parasite, so that the percentage of superparasitism became high and the host mortality caused by parasitism was lower than had been expected from high parasite densities in both 1978 and 1979. Besides, in the first generation of 1979, the adult wasps emerged from 48% of the overwintered parasitised cocoons of the first generation of 1978, whereas they emerged from only 5% of those of the second generation. This difference also seems to have been caused by temporal uncoincidence between the second-generation cocoons and the second-generation adult wasps, since the adult wasps of the first generation in 1979 emerged from 36% of the first-generation cocoons that were parasitised by the wasps of the second generation in 1978.

4P,21

ANALYSIS OF PREDATOR-PREY SYSTEMS IN PATCHY ENVIRONMENTS WITH A NEW STATISTICAL METHOD.

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Studies on persistence of predator-prey systems in patchy environments have been carried out by many authors both experimentally and theoretically since Huffaker (1958). I introduce a new method to describe them which is based on the concept of "interspecies mean crowding" proposed by Lloyd (1967) and Iwao (1977). Here, $\mu_{XY}(s,t)$ is defined as the average number of individuals of species Y which are located in the patch at a distance s from an individual of species X after time interval t. Four kinds of indices are derived from different conbinations of prey (P) and predator (Q); μ_{PP}, μ_{PQ}, μ_{QP}, μ_{QQ}. Using these indices, we could evaluate the characteristics of predator and prey with respect to their reproduction and migration in patchy environments quantitatively, and clarify the processes which are responsible for the persistence of the interactive systems. For example, behaviours of the predator-prey model by Lotka-Volterra, and that by Maynard Smith (1974) could be analyzed with this statistical methods.

4P,22

COMPARATIVE STUDIES ON LIFE HISTORY STRATEGIES OF TWO CONGENERIC SAWFLIES.

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Two sawfly species belonging to the genus Arge (Hymenoptera; Argidae), A. nigrinodosa and A. nipponensis, have been studied from the viewpoint of life history strategy with particular reference to gregarious and solitary modes of their life. Both species are distributed widely in Japan, appear from May to November with several generations and utilize the same food plant, the rose (Rosa multiflora).

In A. nigrinodosa, females lay egg masses into the new shoot of rose with a clear preference for the position and thickness of shoot, and egg masses per shoot are distributed uniformly. Newly hatched larvae form a compact aggregation near the tip of shoot. Aggregations are considered to be led not by physical and chemical factors or by mutual contacts, but by each larva moving according to the fixed behavioural patterns. Larvae systematically feed on leaflets from the tip toward the root as maintaining aggregations through most of the larval stage. But larvae reared in isolation did not show increase in mortality and delayed developments etc., indicating that so-called "aggregation effect" is not appreciable. In the experiment inoculating one newly hatched larva per shoot in the field, significant differences in mortality during later larval stage were not observed between naturally gregarious and artificially isolated groups.

By contrast, A. nipponensis females lay eggs singly or in pairs on the leaflet's edge of rose. Newly hatched larvae feed on leaflets solitarily. Because of these behaviours, this species is considered to be able to utilize even scarce or scattered food resources.

4P,23

SIGNIFICANCE OF AGGREGATION IN THE LIFE HISTORY OF THE PREDATOR *AGRIOSPHODRUS DOHRNI* SIGNORET (HEMIPTERA : REDUVIIDAE).

Inoue, H. (Ent. Lab., Col. Agr., Kyoto Univ., Kyoto, 606 Japan)

A.dohrni is a univoltine Reduviid living on trees and feeding on insects of various kinds. Femails lay 40 to 70 eggs in a mass in mid-June which hatch simultaneously after about a month. Nymphs hibernate in the final instar and adults emerge in mid-spring. An important life history characteristic of *A.dohrni* is the maintenance of strong gregariousness throughout the nymphal stage which is found only in this species among Redviids in Japan. In natural populations, the aggregative behavior is observed in the following aspects of its natural life.

(1) Most of the life-time is allotted to resting at hollows in aggregation. Such sites are used as a shelter for molting and hibernation.

(2) Searching individuals are apt to form a group. If the prey captured is smaller in size than the predator nymph, it prevents other nymphs' entry into feeding. But if the prey is too large to use up, the nymph permits others' entry into feeding. This results in increased frequency of group feeding with increasing prey size.

There is heavy cannibalism only in the period of the first instar. It occurs irrespective of the predator's population density or hunger level. The only factor which determines the intensity of cannibalism is a time lag in hatching among different colonies. Each instar nymph has a strong tolerance to starvation and adult femails need only a small quantity of food for their successful reproduction.

These facts suggest that this species has evolved under short supply of food. Gregariousness of this species would therefore be an adaptation for effective utilization of limited food resource.

4P,24 GREGARIOUSNESS OF *PRYERIA SINICA* LARVAE AS A STRATEGY FOR EXPLOITING FOOD RESOURCES.

Tsubaki, Y. (Laboratory of Applied Entomology and Nematology, Faculty of Agriculture, Nagoya University, Nagoya 464, Japan)

Pryeria sinica (Zygaenidae:Lepidoptera) larvae feed on growing young leaves of *Euonymus japonicus* in a clump. The host plants, infested with many larvae, are often observed to be nuded by grazing of them。 Then, the larvae are occasionally subject to serious shortage in food resources。 In such cases, natural selection will favor those individuals that use the food resources economically. I build up a working hypothesis that the aggregation is an adaptation in larval behavior aimed at maximizing the efficiency in the use of food resources. In order to test this, the patterns of resource utilization were studied on larvae settled on shoots of host plant in varied clump sizes. The amount of food resources in a shoot was affected by three factors: (1) growth of shoot, (2) food consumption of larvae, and (3) inhibition of the growth or degeneration of shoot by larval activity (loss in resource)。 These factors were measured quantitatively and the efficiency in resource utilization was compared among clumps. As the result, the loss in resource was shown to be decreased with clump size, i.e., the larger the clump size, the more economically larvae used the food resources.

4P,25 POPULATION DYNAMICS OF ARTIFICIALLY INTRODUCED PHYTOPHAGOUS LADY-BEETLES, *HENOSEPILACHNA PUSTULOSA* (KONO). LIFE TABLE AND KEY FACTOR ANALYSIS (1975-79)

Sawada, H. and Ohgushi, T. (Ent. Lab. Col. Agric. Kyoto Univ., Kyoto, 606 Japan)

This study on population dynamics of an artificially introduced phytophagous lady-beetle, *Henosepilachna pustulosa* (Kono), was carried out from 1975 in the botanical garden situated in the campus of Kyoto University. This population originated from 30♀♀and 15♂♂ that were artificially introduced in 1971 from Ashu Experimental Forest of Kyoto University. While the population dynamics of this species is characterised by low density and high stability in the original habitat, Ashu (Nakamura and Ohgushi, 1979), this introduced population attained such a high density that they defoliate violently thistle population on which they live, in a few years after introduction. In this population, compared with that of Ashu, the survival rate on the stages from egg to the middle-instar larvae is remarkably high, and a great number of final instar larvae appear and eat up most of food resource.

As regards the life table analysis from egg to adult emergence in each year, the key factor (that determines difference of fluctuations according to place) lay in food shortage on the stage of final instar larvae in 1975, but in 1976 it was in the young larval period and the main cause of death seems to be predation by lady-beetle, *Harmonia axyridis* P. Also in 1977, the key stage lay in the young larval period, and mortality during this stage became density dependent, though such tendency had not been seen in the preceding year. Such yearly transition of the key factors in population changes might suggest the process with which this introduced population is fitting into the community structure of the new habitat.

4P,26 POPULATION DYNAMICS OF THE 28-SPOTTED LADY BEETLE,*HENOSEPILACHNA VIGINTIOCTOPUNCTATA* F。,WITH SPECIAL REFERENCE TO ADULT DISPERSAL AMONG PATCHES。

Hirano,K。(Lab。Appl.Ent。& Nemat。,Nagoya Univ。Nagoya,464 Japan)

The dynamics of numbers in a small population of the 28-spotted lady bettle,which feeds on *Solanaceae* plants and has two generations a year,was studied in 1976-78。 The study area was topographically isolated from other areas. A particular attention was paid to the adult dispersal among 20 patchy habitats with different composition and amount of host plants。 Overwintered adults laid eggs on potato plants in May,and the adults of the 1st generation emerged in late June to early July。 These adults dispersed to egg plants, tomato plants and some other crops,and laid eggs mainly on egg plants。 The adults of the second generation emerged in late July to early August。 These adults migrated overwintering sites after late August。 During 6 consecutive generations,the density of the entire population in the study area was fairly stable. The increase in adult mortality,possibly involved in the dispersal process ,and the reduction in fecundity with increasing adult density seem to be the most important factor for stabilizing the density in the study area。

4P,27 MIGRATION OF THE CUCUMBER BEETLE, *AULACOPHORA FEMORALIS* M.(COLEOPTERA: CHRYSOMERIDAE) AMONG PATCHILY DISTRIBUTED HABITATS.

Kuba, H. (Okinawa Pref. Agric. Exp. Stn., Naha, 903 Japan)

In order to find the role of adult movement in the population dynamics of the cucumber beetle, the migration of this insects was studied in 1977-78. Experiments were carried out in the breeding seasons of summer and in the fall and spring when adults move between breeding sites and hibernating ones. Group marking method was used for detecting the movement of adults. Adults captured in the fields were marked with lacquer paints on the abdominal sternum and/or with pin holes on the elytron to indicate the site(patch) and the date of the first capture. A negative correlation was found between the density of overwintered adults in the breeding sites and the rate of adult population change from the overwintered to the newly emerged in the sites. This correlation suggested that weak density dependent process operated in the breeding population. Adults moved frequently among patches, but the rate of dispersal did not depend on density of adults in the patches, except in overwintered females. This density dependent dispersal of overwintered females might be caused by interference among ovipositing females, and was seemed to contribute the population stability in the heterogeneous environment. In the fall, a conspicuous migration for hibernation was observed.

4P,28 LIFE HISTORY STRATEGY OF THE SWALLOWTAIL BUTTERFLY (*PAPILIO XUTHUS*) WITH SPECIAL REFERENCE TO ITS HOST PLANT

Watanabe,M. (Lab. Forest Zool.,Tokyo Univ., Tokyo 113 Japan)

The long-term study on population dynamics of the swallowtail butterfly, *Papilio xuthus*, was studied by means of the life table analysis in a hilly region including a deforested area, where the host plant, *Zanthoxylum ailanthoides*, was growing. The number of eggs laid on the host plant in the deforested area decreased as the secondary succession progressed, while it did not in the other area. The oviposition behavior and the life tables suggested that the tall host plant was unsuitable for *P. xuthus*. The life tables for the artificially inoculated populations on the tall host plants were compared with those on the natural populations on the short host plants or/and the seedlings. As the results, the characteristics of the population dynamics of the host plant were clarified, and then, discussed.

4P,30

THE POPULATION DYNAMICS OF CERATITIS CAPITATA WIED. IN SARDINIA.
Prota, R., Delrio, G. (Ist. Ent. agr., Univ., Sassari, Italia)

Adult population densities of C. capitata in fruit growing areas of Sardinia were monitored between 1973 and 1979 using sticky traps. Regional variations in abundance can be attributed to differing climatic regimes and varying agricultural practices. The role of proximate climatic factors in determining population densities has been investigated, and the possibility of incorporating such data into predictive control programmes against the species has been appraised. The overwintering strategies of C. capitata have been studied. The exploitation of commercially grown fruit as ovipositing sites by the flies has been investigated, and the implications of this research to future agronomic policies in Sardinia has been considered.

4P,32

POPULATION ECOLOGY OF TWO POLYPHAGUOUS-PREDACEOUS BEETLES OF THE FOREST FLOOR. Brunsting, A.M.H., Heessen, H.J.L.; Laboratorium vöor Zoölogische Oecologie en Taxonomie, Rijksuniversiteit, Utrecht (The Netherlands).

Two common beetles of the forest floor, Pterostichus oblongopunctatus F. (Carabidae) and Philonthus decorus Fabr. (Staphylinidae) have been studied. Their niches are very similar. Fluctuations in density and distributional pattern are small, compared with the well known examples of insects causing pests. But differences in this respect still exist between the two species. Philonthus decorus, which is confronted with the lowest environmental predictability, does respond with a higher percentage of specimens within the population with the capacity of dispersal (i.c. well developed flight muscles) and not with the higher maximal rate of increase ($\frac{1}{4}$ x). Density dependent regulation of density has been proved experimentaly to operate in field populations of both species, but most convincing for Pterostichus oblongopunctatus. The effects of varying the density of larvae and the amount of food pointed to the effective, and presumably big, role of cannibalism in this respect, both in laboratory and field experiments.

4P,33

POPULATION STUDIES ON TWO CARABID BEETLES, CARABUS YACONINUS AND C. KUMAGAII. (COLEOPTERA,CARABIDAE). SOTA, T.(Entomological Laboratory, College of Agriculture, Kyoto University, Kyoto, 606 Japan)

Population studies on two carabid beetles, *Carabus yaconinus* and *C. kumagaii* were carried out in the botanical garden of Kyoto University in 1979. The purpose of this study is to clarify the dynamic features of these predatory insect populations within their habitats. Seventy five pit-fall traps were arranged at regular intervals of 15m over the study area(16500 square meters). Marking, release and recapture method was used to estimate population parameters by Jolly-Seber method.

Two subpopulations for both species were recognized within the study area from the movements of marked animals. The number of overwintered adults of a spring-breeder, *C.yaconinus* was estimated as about 500 and the population size was rather stable until the beginning of the emergence of new adults in late June. The emergence continued to November and emerged adults were most abundant in July and October. From late July to early September, the estimated number including both overwintered and new adults approached to about 2000. Survival rate was low in this period and the rate of new adults rapidly increased. In autumn, the population became to be composed by almost new adults. *C.kumagaii* is an autumn-breeder. Its population size was relatively small and period of activity was shorter than that of *C.yaconinus*. About 200 of new adults emerged in June, and they aestivated in mid summer and became active again in September. Daily survival rates estimated were constantly high and the population seemed to be stable.

4P,34 A COMPARAISON OF THE STRUCTURE OF THE INSECT COMMUNITIES FROM MEADOWS PONDS OR FROM PONDS LOCATED IN FIELDS HEAVILY SPRAYED BY PESTICIDES.

ECHAUBARD Michel, RAMADE Francois, LE BRAS SUZETTE, and MORETEAU Jean-Claude.

With the object of investigated the effects of pesticides and chemical manures in intensive agricultual field on aquatic environment, we have compared the insects communities from three meadows ponds or from three ponds located in fields heavily sprayed by pesticides.

The utilization of correlation matrix and dendograms show that the insects communities from the three meadows ponds are fondamentally differents from the three ponds located in fields.

4P,36 Seasonal Occurrence of Simulium spp. (Diptera, Simuliidae) in northern Iraq.

Abul-hab, J. (Dept. of Pl. Prot. Research, Abu-ghraib, Iraq)

Population dynamics of *Simulium kiritschenkoi* Rubzov and *S. mediterraneum* Puri (Diptera, Simulidae) in Ahmadawa, Sulaimanyyah, northern Iraq, were studied by man-hour collecting of larvae and pupae in monthly visits, 1977. Breeding was continuous during the whole year, with a slow down during the winter months when fewer pupae and mature larvae were collected. Overwintering, if any, is in the mature larval stages.

4P,37 BIOCOENOTIC CHANGES INDUCED IN PONDS LOCATED IN FIELDS AREAS POLLUTED BY PESTICIDES

F. RAMADE, M. ECHAUBARD, S. LE BRAS, J. C. MORETEAU.

Quantitatives differences in the structure of aquatic insects communities have been shown up between meadows ponds and ponds located in the middle of corn or wheat fields regularly sprayed with pesticides, in our area sited 30 miles S. O. of Paris.

These changes mainly stem in a decrease of the specific richness, Shannon's diversity and equitability index. Unexpectedly organochlorine residues levels in water, sediments and insects are low, not much significantly differents of those found in ponds located in unsprayed meadows.

4P,38

INSECT-FAUNA SURVEY FOR THE PROTECTION OF NATURAL ENVIRONMENT.

Okutani,T.(Ent.Lab.,Kobe Univ.,Kobe,657 Japan)

In 1978, the Entomological Society of Japan surveyed some insect-fauna of Japan sponsor-financed by Environment Agency to lay the faundation for the protection of natural environment.

The following ten species were surveyed all over Japan as an index-species: Epiophlebia superstes, Tanypteryx pryeri, Nannophys pygmacea, Glliloblattodea spp. Lethocerus deyrollei, Luehdorfia japonica, L. puziloi, Sasakia charonda, and Luciola cruciata.

And 50 - 100 species were selected as specified species by responsible specialists in each prefecture. The total number of the specified species are about 3,500 and net number about 1,600 species. The reports of each species were arranged in maps and lists of localities.

4P,39

STRUCTURE OF INSECT COMMUNITIES: THE CORE AND THE SATELLITE SPECIES. Hanski, I. (A.E.R.G. Dept. Zool., Oxford Univ. Oxford OX1 3PS, U.K.)

A simple mathematical model describing the extent of spatial distribution predicts that the proportion of population sites occupied by one species in the course of time is bimodal, provided that the variance of the 'spatial growth parameter' exceeds its mean value. The same argument is extended to a community of species, and the hypothesis is put forward that because of stochasticity in spatial population dynamics insect communities largely consist of two kinds of species, called 'core' and 'satellite' species. The former are locally abundant, widely distributed, and relatively well spaced-out in the niche space, whilst the satellite species are less abundant locally, are patchily distributed in space, and less well spaced-out in the niche space. This hypothesis thus attempts to unite the three structural aspects in communities: abundance and niche relations with spatial variation. Data are given on the communities of bumblebees, leafhoppers, dung beetles, and mangrove island insects to support the assumptions and predictions of the model.

4P,40

ECOLOGICAL PECULIARITIES OF DENDROPHILOUS INSECTS: CO-EVOLUTIONAL APPROACH. Baranchikov Yu.N. (Inst.Forest and Wood Sib.Br.USSR Ac.Sci., Krasnoyarsk, 660036, USSR)

The comparison among the phyllotrophic insects inhabiting the higher dicotyledonous plants of the Boreal Holarctic has shown the significant differences between dendro- and chortophilous species of Lepidoptera, Coleoptera, Hymenoptera and Homoptera. These differences concern almost all the ecological characteristics: body size, fecundity, growth rate, duration of the larva stage development, voltinis, phenology, migration ability of imagos, spatial structure of populations and their optimal number, variety of trophic base, energy expenditure for feeding, utilisation of separate food components, efficiency of conversion of ingested and digested food to body substance. The causes lie in the chemical protection peculiarities of trees and shrubs and in their distribution in space and time, as compared to those of herbs (Feeny, 1975). The formation of the given characteristics of woody plants and their insect fauna is a result of the co-evolutional adaptations of phytophagous insects and plant life forms.

4P,41 A TECHNIQUE FOR ESTIMATING AND PREDICTING ORIENTAL FRUIT FLY POPULATION DENSITY USING THE KALMAN FILTER. Harris, E. J. (USDA-AR-SEA, Honolulu, Hawaii 96804); Ford-Livene, C. (Dept. Math., Calif. State Polytech. Univ. Pomona, Calif. USA)

A multidimensional system involving various development stages of the oriental fruit fly (*Dacus dorsalis*` Hendel), its parasites, host fruits, and weather conditions is described by means of a piece wise linear vector difference equation. The state of the ecosystem is observed via stratified random sampling. Kalman filter techniques are used to obtain optimal estimates of the various compenents of the system which are then compared with the predicted values. A computer simulation of the model is presented which is applicable to other insect populations.

Section 5.

Genetics and Developmental Biology.

5S-1,1 RESEARCH ON ECDYSONE BIOSYNTHESIS AND METABOLISM IN OVARIES AND EMBRYOS OF INSECTS : RECENT DEVELOPMENTS.

Hoffmann, J.A., Lagueux M. and Hetru C. (CNRS, Labor. Biol. Générale, L. Pasteur Univ., 67000 Strasbourg, France)

It is by now an accepted fact that ovaries of adult insects synthesize ecdysteroids. In most species investigated, these molecules are accumulated in the oocytes and are present in the newly-laid eggs. Ovaries and eggs contain a surprisingly large variety of ecdysteroids in either free or conjugated form and the paper will give recent results obtained in Locusta migratoria concerning (1) chemical identifications of various endogenous ecdysteroids, (2) in vivo and in vitro studies of the metabolic fate of labelled ecdysone precursors and ecdysone. Special attention will be devoted to the chemistry and biological relevance of highly polar ecdysteroids ("conjugates") wich are present in large concentrations in oocytes and newly-laid eggs.

5S-1,2 ECDYSTEROIDS IN OVARIES OF THE SILKWORM, BOMBYX MORI

Ikekawa, N., Ikeda, T., Mizuno, T., and Ohnishi, E. (Lab. Chem. Nat. Prods., Tokyo Inst. Tech., Yokohama, 227, and Biol. Inst., Nagoya Univ., Nagoya, 464 Japan)

In ovaries of the silkworm, Bombyx mori, we have reported the presence of an ecdysteroid of unknown structure, in addition of 2-deoxy-ecdysone and ecdysone (E. Ohnishi et al., Science, 197, 66(1977)). Chemical analysis involving mass spectrometry and FT-nmr revealed its structure as 2,22-bisdeoxy-20-hydroxy-ecdysone. Biological activity of this compound as tested by isolated abdomen of the fleshfly, Sarcophaga peregrina, is about one tenth of that of ecdysone. During the course of the purification, we detected an another ecdysteroid, whose structure was determined as 2-deoxy-20-hydroxy-ecdysone by direct comparison with authentic sample. Although exact role of those ecdysteroids in ovary is not clear at present, less hydroxyl ecdysteroids may be intermediates of biosynthetic pathway of ecdysone. Thus, we propose the biosynthetic pathway of Bombyx ovarian system as follows: oxidation at C-6, C-14, C-25 undergoes first, and then the pathway is forked into two branches. One pathway is leading to ecdysone and the other to 20-hydroxy-ecdysone.

5S-1,3 ENZYMATIC CONVERSION AND INACTIVATION OF ECDYSONE IN THE BLOWFLY

Koolman, J. and Reum, L. (Physiol.-Chem. Institut, Univ. Marburg, D-3550 Marburg, West Germany)

In larvae of the blowfly, Calliphora vicina, ecdysone is rapidly metabolised following its secretion by the ring gland. The main reaction (90 %) is hydroxylation at the C-20 position, to ecdysterone. Ecdysone and ecdysterone are also hydroxylated at C-26. A minor reaction results in the formation of 26-hydroxy-25-deoxyecdysterone (inokosterone). On the other hand, the metabolism of ecdysone is slow at the pupal stage of the development. Oxidation at the C-3 position to 3-dehydro derivatives predominates. Subsequently the 3-dehydro derivatives can be reduced to 3-epi-ecdysteroids.

The conversion of ecdysone to ecdysterone in larvae is interpreted as the activation step of the moulting hormone. However, the biological significance of this hydroxylation is, at present, not understood completely. All the other known reactions involving ecdysone and ecdysterone, diminish their biological activity. Hence, they are regarded as steps toward the inactivation of the hormone (reaction type I). Ecdysteroids are eventually converted to inactive substances by the formation of conjugates (reaction type II). On the basis of kinetic analyses, performed in vitro and in vivo, on the catabolism of ecdysteroids by blowfly larvae and pupae, the relevance of the enzymatic reactions are discussed.

5S-1,4 ACTION OF ECDYSTEROIDS ON THE DIFFERENTIATION OF EMBRYONIC CELLS OF ESTABLISHED LINES OF DROSOPHILA MELANOGASTER IN VITRO. Courgeon, A.M. and Best-Belpomme, M. (Lab. Zool., Univ. Paris VI. Paris, France)

The in vitro cultured embryonic cells of Drosophila melanogaster were used as a model for the study of the ecdysteroid hormones: ecdysone and 20-hydroxy-ecdysone (=ecdysterone). Some clones are ecdysone (10^{-6}M) and ecdysterone (10^{-8}M) sensitive. The cells respond by specific morphological modifications and stop dividing. Two enzymes which cannot be detected in untreated cells are induced by ecdysterone: acetylcholinesterase and beta-galactosidase. If the cells are "matured" by a subthreshold concentration they give a quicker and higher enzymatic response. We also showed an ecdysteroid induced class of proteins against which antibodies were prepared. They allowed to see that these proteins have common antigenic properties with proteins present in adult Drosophila. Saturable receptors of ecdysterone were demonstrated in the sensitive clones but they could not be found in resistant clones which do not respond to ecdysteroids.

5S-1,5 THE EFFECT OF ECDYSTEROIDS UPON CULTURED DROSOPHILA CELLS. Alvarez, C., Monahan, J., Sage, B., Stevens, B., O'Connor, J.D., Dept. Zool. UCLA, Los Angeles, CA 90024

The effect of ecdysteroids upon cloned cell lines derived from embryos of Drosophila melanogaster has been examined. A number of distinctly different responses have been obtained including cell lysis, elongation and clumping in addition to specific enzyme induction. Responsive clones all possess high affinity cytoplasmic and nuclear receptors, the characteristics of which are well described. Following exposure to ^{3}H-Ponasterone, bound ligand first appears in the cytosol and subsequently in the nucleus. This translocation of ligand may not involve the translocation of the cytosol receptor but rather a facilitated shifting of hormone from cytosol to nucleus via a receptor mediated process. The data for and the implication of such a mechanism are discussed.

5S-1,6 EARLY EVENTS IN THE RESPONSE OF IMAGINAL DISCS TO ECDYSTEROIDS. Fristrom, J., Yund, M.A., and Hill, R. (Dept. of Genetics, Univ. of Calif., Berkeley, CA 94720, U.S.A. and Cell and Molecular Biology Unit, CSIRO, Sydney, Australia).

Imaginal discs of Drosophila melanogaster respond to ecdysteroids in vitro by undergoing morphogenesis with the formation of appendages (legs, wings) and differentiation with the formation of both exo- and procuticles. Using 3-H-Ponasterone A, receptors for ecdysteroids have been identified in imaginal discs. These receptors bind ecdysteroids with the expected specificity and affinity. The receptors in mature discs are located in nuclei and are believed to be non-histone chromosomal proteins. One of the early responses to the presence of ecdysteroids is altered synthesis of specific non-histone chromosomal proteins. Two of these proteins have isoelectric points and molecular weights similar to vertebrate steroid receptors. These observations indicate that the primary action of ecdysteroids on imaginal discs involved modulation on transcriptional activities.

5S-1,7 REGULATION OF GENE EXPRESSION IN LARVAL FAT BODIES OF DROSOPHILA.

Garen, A., Lepesant, J. A., Levine, M., and Lepesant-Kejzlarova, J. (Dept. Molecular Biophysics and Biochemistry, Yale Univ., New Haven, CT USA)

This presentation concerns a genetic and molecular study of the regulated transcription in larval fat bodies of several genes. One is the Pl gene which is ecdysone-inducible and maps at a single site on the third-chromosome. Rapid transcription and translation of the Pl gene begins late in the third-instar larval stage, specifically in the fat bodies. We have isolated several cloned genomic segments containing the Pl structural gene and also extensive flanking DNA sequences. A search for proteins that bind specifically to the cloned DNA is in progress. Mutants are being isolated that map in the region of the Pl gene, and these are being tested for defects in the structural or regulatory functions of the Pl gene in order to identify Pl mutants. Similar studies are in progress for the major larval serum proteins Lsp-2, which has a single structural gene, and Lsp-1, which has three separate and unlinked structural genes, one for each of the three nonidentical subunits of the multimeric Lsp-1 protein.

5S-1,8 PURIFICATION OF LECTIN INDUCED IN THE HAEMOLYMPH OF SARCOPHAGA PEREGRINA LARVAE ON INJURY.

Shunji Natori (Fac. Pharmaceutical Sciences, Univ. of Tokyo, Tokyo, 113 Japan)

A lectin was purified from the haemolymph of Sarcophaga peregrina larvae, obtained after injury of their body wall. This lectin agglutinated sheep red blood cells markedly and the haemagglutinating activity was inhibited by galactose and lactose. The active lectin was found to have a molecular weight of 190,000 and to consist of four α subunits and two β subunits, with molecular weights of 32,000 and 30,000, respectively. During the early pupal stage, similar haemagglutinating activity in the haemolymph increased to several times than in larval haemolymph. This activity was completely inhibited by the antibody prepared against the lectin purified from the haemolymph of injured larvae. Thus, the same protein having lectin activity is apparently induced under two different physiological conditions: injury of the body wall of larvae, and during pupation. The biological significance of this lectin will be discussed in terms of ecdysone action.

5S-1,9 ECDYSTEROID SYNTHESIS IN SEVERAL TISSUES OF DIFFERENT INSECT SPECIES

Romer, F. (Inst. f. Zoologie d. Universitat Saarstr.21, 6500 Mainz West-Germany)

Prothoracic glands are said to be the only sites in which the molting hormone ecdysone is produced. In some recent papers a synthesis of the hormone in isolated abdomina is reported. However the tissue in which the synthesis takes place is not yet identified exactly. Investigations in our laboratory concerning the fine structure of some abdominal tissues resulted in features typical of steroid producing cells in the oenocytes. Tissue cultures of prothoracic glands, oenocytes and other organs were established for Tenebrio molitor, Bombyx mori and Gryllus bimaculatus. The tissues mentioned were kept in vitro for several hours, extracted and separated by TLC. The incubation of single tissues resulted in an ecdysone synthesis in prothoracic glands, oenocytes, thoracic fat body and tergites.
In the other organs investigated the production rate was very small. The ecdysteroids built in single organs cannot explain the amount reached at the hormone titre maximum (about 2/ug/g fresh weight). Only combinations of prothoracic glands, oenocytes nad tergites each together with thoracic fat body could explain the values at titre maximum. The amount of synthesis within the molting cycle runs parallel to the changes of hormone titre found in whole animals. The products synthesized in vitro were analysed by GLC and tested with a bioassay.

5S-2,10

Insect cells *in vitro*: an overview. Maramorosch, Karl, Waksman Inst. of Micro., Rutgers U., New Brunswick, NJ 08901, USA

During the past decade considerable progress has been achieved in establishment of cell lines, cloning, applications to studies of cell biology and propagation of viruses and parasites in invertebrate cells. Culture media have been improved and simplified and amino acid requirements studied in great detail. Among specific applications of insect cell cultures the most notable have been molecular genetic studies in Drosophila cells, arbovirus investigations, maintenance of protozoan parasites, propagation of Baculoviruses, studies of parasite-cell interactions, responses of cells to insect hormones and use of leafhopper cell lines in the study of plant pathogenic viruses. The symposium participants, all recognized authorities in their specialized fields, have made outstanding contributions to insect cell culture. Their achievements attest to the rapid and continuing advances in this important area of entomology.

5S-2,11

DEVELOPMENT OF INSECT CELL CULTURES. GRACE, T., (Australian Embassy, Tokyo)

Insect tissue culture was first attempted by Goldschmidt in 1915. The first successful cell outgrowth was obtained by Trager (1935) from the ovarian tissues of *Bombyx mori.* However, the development of insect cell cultures was slow compared with that of vertebrate cell culture. In the early stages, natural media were mostly used but in 1953 Wyatt formulated a synthetic medium for insect cell cultures, based on an analysis of the chemical composition of insect blood. Modifying Wyatt's medium, Grace (1962) established the first insect cell line from the ovarian tissue of *Antheraea eucalypti.* Since then, using mostly the same techniques as in vertebrate tissue culture more than 100 cell lines have been reported. Insect cell lines have been used in a wide range of studies in medicine, biology and agriculture including molecular biology, biochemistry, cell physiology, morphology, cytogenetics, pharmacology, toxicology, virology and agriculture. The cultured cells have been especially useful in studies of the replication of arbo- plant and insect viruses. Although the established insect cell lines have been widely used, the characterization of each cell line has not been studied enough. This will be a future problem.

5S-2,12

IN VITRO CHARACTERIZATION OF EMBRYONIC CELLS FROM *DROSOPHILA MELANOGASTER* IN PRIMARY CULTURES. Kuroda, Y. (Nat. Inst. Genetics, Michima, Shizuoka, 411 Japan)

Embryonic cells from *Drosophila melanogaster* were cultured *in vitro* and the characterization of some cell types in primary cultures were carried out. When cells from embryos at the stage of post-gastrulation were cultured, muscle cells, epithelial cells, fibroblastic cells, small cells, imaginal disc cells, fat body cells, and nerve cells were characterized under an inverted phasecontrast microscope. Muscle cells were spindle shaped and fused to form multinucleated myotubes. They pulsated synchronously when two or more cells made contact with each other. Polygonal epithelial cells contained many cytoplasmic granules. Imaginal disc cells were characterized by the formation of cellular spheres. Nerve cells formed many nerve fibers which were extended and branched in many directions. Small droplets were secreted on the nerve fibers.

5S-2,13 CHARACTERIZATION AND IDENTIFICATION OF DIFFERENTIATED CELL TYPES GROWN FROM DROSOPHILA EMBRYOS IN PRIMARY CELL CULTURES. Dübendorfer, A. (Dept. Zool., Univ. Zürich, Switzerland)

Studies of developmental processes in primary cell cultures set up from Drosophila embryos depend on the reliable recognition of the various cell types and their physiological state. Since the differentiation of separated cells in vitro is considerably slower than in normal organogenesis we need to know a cell type which, in the course of development, changes enough to serve as a marker for the various developmental stages (embryonic, larval, pupal, and adult, respectively). For this purpose the differentiating larval fat body cells have proven particularely suitable. The development of this cell type in vitro was studied with respect to morphology, ultrastructure, and molecular function, i.e., the ability to convert tritiated ecdysone into 20-hydroxy-ecdysone, and the results were compared to the normal development of fat body tissue in situ.

Many cell types, such as hemocytes, have so far been identified purely by their morphology. Obviously, for clear identification one should know more about the function of these cells. Time lapse video recording of developing primary cell cultures during their early stages and at the time of ecdysteroid-induced metamorphosis revealed specific cellular functions, such as phagocytosis by flattened, lamellocyte - type hemocytes.

5S-2,14 CHROMOSOMAL PHENOMENA IN CELL LINES OF DROSOPHILA. Barigozzi, C. (Univ. Milano, Inst. Gen., Milano, Italy)

The chromosomal phenomena observed in several permanent cell lines of Drosophila melanogaster at different time periods are described. They consist in both numerical and structural mutations. Emphasis is laid on the behaviour of eu- and heterochromatin.

5S-2,15 SPECIFIC OXYGEN REQUIREMENTS OF DIFFERENTIATED INSECT CELLS AND THE PROBLEM OF IDENTIFICATION OF THE TISSULAR ORIGIN OF IN VITRO ESTABLISHED CELL LINES Echalier, Guy (Lab. Zool., Univ. ParisVI, 75005, France)

In Insect organism, the spatial organization of tissues provides their cells with very specific local conditions. Such micro-environments should be essential for performing highly differentiated cell programs.

In vitro, as a contrast, the standardized culture conditions we offer the cells are most probably responsible for the uniform morphology (the so-called "fibroblast-like" appearance) displayed by most of line cells and for the comparative monotony of their metabolic programs. A few specific biochemical pathways, however, may be kept open (or inducible), so disclosing the tissue origin of the line.

One important component of this cell microclimate is undoubtedly oxygen availability, because only aerobic pathways might support the high energetic cost of some complex programs of cell differentiation.

To test this hypothesis, several Drosophila cell lines have been grown under various conditions of oxygenation, and their capacities for responding to hormonal stimulus have been compared. The nature and extent of such induced "luxury" metabolic pathways may give us some valuable clues to their tissularderivation.

5S-2,16 REQUIREMENTS OF AMINO ACIDS BY INSECT CELL LINES. J. Mitsuhashi (Div. Ent., Nat. Inst. Agr. Sci., Tsukuba, 300-21 Japan)

Informations about requirements of amino acids by insect cell lines are beneficial not only for the insect physiology but also for the formulation of culture media. The requirements can only be determined by the use of single amino acid deficient media. By this method several insect cell lines were examined. The essential amino acids for the most insect cell lines were found to be arginine, cystine, glutamine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, proline, serine, threonine, tryptophan, tyrosine and valine. However, a recently established cell line from the cabbage armyworm, Mamestra brassicae, showed exceptionally low amino acid requirements. The essential amino acids for the growth of this cell line were only cystine, histidine, isoleucine, methionine and threonine. The cells could grow when other amino acids were deleted one at a time.

5S-2,17 REPLICATION OF ARBOVIRUSES IN ARTHROPOD IN VITRO SYSTEMS: AN OVERVIEW. Pudney, M., Leake, C.J. and Buckley, S.M. (Dept.Ent., LSHTM, London, England, Yale University,Dept. YARU,New Haven,Ct.)

The value of arthropod cell cultures in arbovirus in vitro studies is self evident from a brief survey of the literature. Cell lines from both mosquitoes and ticks, the major vectors of arboviruses, enable parallel biological characterisation studies to be carried out (Pudney et al., 1979). With the increase in the number of these to the present 43 mosquito (20 species) and 8 tick (6 species) cell lines, a wider view can now be taken, although only selected cell lines have been extensively used. Patterns of behaviour of representative arboviruses in these cell lines will be described and discussed in terms of sensitivity of the cell line, viral growth kinetics, persistent infections, use as a diagnostic tool, primary isolations and the production of plaques.

Pudney, M., Leake, C.J. and Varma, M.G.R. (1979). In: Arctic and Tropical Arboviruses, Ed. E. Kurstak, Academic Press, pp. 245-262.

5S-2,18 SUSCEPTIBILITY OF INSECT CELL LINES TO VIRUS CHALLENGE. Vaughn, J. L. and Goodwin, R. H. (USDA, SEA, Insect Pathology Laboratory, Beltsville, Maryland 20705)

The characteristic susceptibility of an insect cell line to challenge by a specific virus is one of the useful characters of any line. Although this characteristic is only of limited use in identifying a cell line it is of considerable practical value. Cell lines are widely used to study the replication of many groups of viruses associated with insects, i.e., arboviruses, reoviruses, baculoviruses, poxviruses, iridescent viruses and picornaviruses. Research is being performed to develop cell lines which will be suitable for the production of viruses on a commercial scale for use in pest management. Cell lines which replicate arboviruses are being considered for use in vaccine production. Thus, several insect cell lines, e.g., Singh's Aedes albopictus and Hink's Trichoplusia ni, are well characterized with regard to their capability to replicate various viruses.

It was generally assumed that an insect cell line would be susceptible to those viruses that would replicate in the donor host. However, experience has shown that this is not true for all cell lines. Among several cell lines isolated from the gypsy moth, Lymantria dispar, some were permissive, others had mixed populations of permissive and non-permissive cells, and some were totally non-permissive for the nuclear polyhedrosis virus of this insect. Those cells which were non-permissive for the L. dispar NPV were fully permissive for the Autographa californica NPV. All of these cell lines were developed from ovarian tissue from L. dispar pupae. Serological tests on the individual cell lines established that all were related to L. dispar and not to any of the other cell lines present in our laboratory. Similar results have been obtained by other investigators with cell lines from other species. Thus, the susceptibility of each cell line can not be predicted, based upon its origin, but must be experimentally determined.

5S-2,19 CULTURE CONDITIONS REGULATING THE INFECTION OF CELLS BY INTRACELLULAR MICROORGANISMS.

Tsang, K. R. and Brooks, M. A. (Dept. Ent., Univ. Minnesota, St. Paul 55108, USA.)

A line of cockroach cells, UM-BGE-5β , is routinely cultured in modified S-19 medium. These cells were challenged with a microsporidan, *Nosema disstriae*, from a chronically infected line of *Malacosoma disstria* cells, Md66. The cockroach cells did not become infected. The cockroach cells were then adapted to a new medium, UM-1, with less sodium and more potassium, and a lower osmotic pressure, where they grew well. When they were challenged in this with the parasite, they became infected and supported replication of the microorganism. Vegetative stages could be seen in the cytoplasm and spores in the medium. The cell line has remained chronically infected in UM-1. A range of osmotic pressures is being examined to define more clearly the optimal physico-chemical conditions that favor parasitic cross-infection *in vitro*.

5S-3,21 PURIFICATION OF THE PROTHORACICOTROPIC HORMONE OF *BOMBYX MORI*.

Ishizaki,H., Koide,Y. (Biol.Inst., Nagoya Univ., Nagoya, 464 Japan), Suzuki,A., Hori,Y., Nagasawa,H., Isogai,A. and Tamura,S.(Dept. agricult. Chem., Tokyo Univ., Tokyo, 113 Japan)

The prothoracicotropic hormone(PTTH) from adult heads of *Bombyx mori* has been purified to an electrophoretically homogeneous state. 0.3 ng of the pure hormone was effective in causing adult development in a brainless pupa of *Samia cynthia ricini*. On the basis of an estimated molecular weight of 4000, PTTH was calculated to be active at a concentration of 10^{-10}M. The yield of PTTH from 200,000 heads was 60 μg. Some chemical properties of PTTH will be presented.

5S-3,22 THE PROTHORACICOTROPIC HORMONE OF *MANDUCA SEXTA*.

Gilbert, L.I., Bollenbacher, W.E., Granger, N.A. and Agui, N. (Dept. of Biological Sciences, Northwestern University, Evanston, IL 60201 U.S.A.)

A rapid, reproducible and sensitive *in vitro* assay has been developed for the prothoracicotropic hormone (PTTH) of *Manduca sexta*. The assay involves the *in vitro* incubation of specific stage prothoracic glands with PTTH extracts. The stimulation of ecdysone synthesis by the experimental prothoracic glands is compared to that of the control and an activation ratio (A_r) is determined. The data indicate that a 4 to 5-fold stimulation can be expected under these conditions. Using this *in vitro* assay, a single lateral neurosecretory cell has been identified in each hemisphere of the brain of *Manduca* that is responsible for the synthesis of PTTH. These experiments entail the critical dissection of single neurosecretory cells and the ability of the *in vitro* assay to measure the PTTH content of a single neurosecretory cell. Further studies utilizing the assay as well as electron microscopic analysis, suggest that the corpus allatum of *Manduca* is the neurohemal organ for PTTH. The titer of PTTH has been determined during the last larval instar and during larval-pupal metamorphosis. The tissues assayed include the brain, corpora cardiaca, corpora allata and the hemolymph. These data yield insights into the means by which the prothoracicotropic hormone controls the prothoracic glands to secrete ecdysone. Also to be discussed are our studies on the purification of PTTH.

5S-3,23 THE TIMING OF RELEASE OF NEUROSECRETION FROM THE BRAIN OF RHODNIUS PROLIXUS DURING THE MOULT CYCLE AND ITS RELATION TO ECDYSONE TITRES.

Steel, C.G.H. (Dept. Biol., York Univ.,Toronto, Canada)

Moulting in Rhodnius larvae is initiated by a blood meal. Electrical recordings from the axons of the medial neurosecretory cells (MNC) have been obtained throughout the moult cycle and related to changes in the ultrastructure of the MNC and in haemolymph ecdysone titres in the same animals.

There are three main phases of release from the MNC in each moult cycle, each involving the appearance of a bursting firing pattern in the axons and exocytosis of granules at their terminals. The first two phases are each followed rapidly by increases in haemolymph ecdysone titres. Decapitation experiments confirm that these two phases coincide with release of prothoracotropic hormone (PTTH). The second release of PTTH occurs exactly 24 h earlier in females than in males. A new interpretation of the 'critical period' is proposed. The third phase of release occurs at ecdysis and may be involved in the gating of ecdysis behaviour.

5S-3,24 NEUROHORMONE AND REPRODUCTION IN INSECTS

Raabe M. (Lab. Insect Neuroendocr., P.&M. Curie Univ., Paris, France)

Insect hormones, ecdysone and juvenile hormone play a part in the control of reproduction but neurohormones exert the major role in the regulation of the various processes implied in reproduction. Gonadial mitosis is dependent on the A MNC in the bug Panstrongylus megistus, whereas in the same insect, the neurohormone originating in the A' MNC activates the molting gland which triggers the onset of meiosis. Later in development, neurohormones control both vitellogenesis and protein production by the fatbody, regulate sexual behaviour and oviposition. Hence, neurohormones are of great importance in reproduction.

5S-3,25 IDENTIFICATION AND ANALYSIS OF INDIVIDUAL BURSICON NEURONS IN MANDUCA SEXTA.

Taghert, P.H. (Dept. Zool., Univ. Wash., Seattle, WA 98195, USA)

Diverse lines of experimental evidence have been used to identify a particular set of cells as containing bursicon, a neurohormone which triggers the sclerotization of wing vein cuticle following adult emergence in Manduca sexta. These neurons - two symmetric sets of four - have large (~30 μ) cell bodies which are clustered together in a dorso-lateral position in abdominal ganglia. Each member of the cluster contains detectable amounts of hormone in crude cell extracts. Within a cluster, the neurons can be subdivided into two pairs on the basis of differential staining with paraldehyde fucshin.

These neurons are also individually identifiable according to their dendritic morphology as revealed by intracellular dye injection. They, and other non-bursiconergic secretory neurons, project to common areas of the ganglionic neuropile; together these areas constitute a defined neurosecretory neuropile. The dendritic morphology of individual bursicon neurons varies in a proscribed fashion: a discreet point in the secretory neuropile may be the target for one or more dendritic branches which arrive at that target by way of a set of defined alternative paths. This variability in dendritic morphology, however, is not so great as to obscure an individual's identity. Axonal projections also differ within this cluster: three cells exit the ganglion via an ipsilateral segmental nerve to terminate in the neurohaemal transverse nerve; the fourth cell exits via the contralateral, descending connective to a destination which is presently unknown but is likely to be within the central nervous system.

5S-3,26 HUMORAL REGULATION OF ELECTRICAL ACTIVITY OF EXTRA-GANGLIONIC NEUROSECRETORY CELLS.

Finlayson, L. H. (Dept. Zoo., Birmingham Univ., Birmingham B15 2TT, England)

Neurosecretory cells that lie on a peripheral nerve in the stick insect (Carausius morosus) undergo a diel cycle of secretory and electrical activity. The frequency of discharge of action potentials is greater during the dark phase, when the insects are active and feeding, than during the light phase when they are motionless. Using insects which had been reared in reversed and normal photoperiodic regimes of L.D. 12:12 it has been found that haemolymph from animals in the light (inactive) phase has an inhibitory effect on the electrical activity of peripheral neurosecretory cells taken from animals in the dark (active) phase. It is possible to speed up the discharge frequency of cells taken from animals in the light phase by using an appropriate physiological saline until it reaches or exceeds the level normally found in dark phase animals. These cells then become hypersensitive to the inhibitory effect of haemolymph from animals in the light phase.

5S-3,27 THE DIAPAUSE HORMONE - CHEMISTRY AND BIOLOGY

Hasegawa, K., Yamashita, O., Isobe, M., Imai, K. and Goto, T. (Fac. Agric., Nagoya University, Nagoya 464, Japan)

The diapause hormone (DH) secreted from the suboesophageal ganglion in the silkworm Bombyx mori is responsible for induction in egg diapause of this insect. DH additionally affects carbohydrate, lipid and protein metabolism in developing ovaries. DH extracted from male heads was purified mainly by gel chromatography with organic solvents. We obtained two major active principles, DH-A and -B, molecular weight of the former being 3300 and the latter 2000. Both of them were characterized to be peptidal hormones. Although no significant physiological difference in Bombyx was observed between DH-A and -B except higher DH action in the latter, the former functioned to display cuticular melanization in the armyworm larva, Leucania separata.

5S-4,28 THE ORGANIZATION OF HEAT-SHOCK GENES IN DROSOPHILA.

Gehring, W.J. (Dept. Cell Biology, Biozentrum, Univ. of Basel,
CH-4056 Basel)

Upon heat-shock a dramatic change takes place in the transcriptional activity of Drosophila cells. Most genes are switched off and a small set of genes which code for the heat-shock proteins are switched on. There is also a change at the translational level leading to the disaggregation of preexisting polysomes followed by the formation of new polysomes which contain newly transcribed messenger RNA coding for the heat-shock proteins. Most of the heat-shock genes have been cloned in bacterial plasmids and their DNA sequences are being analyzed. The structural organization of these genes will be discussed. The cloned heat-shock genes have been used as a probe to detect sequence specific DNA-binding proteins in nuclei of tissue culture cells and larvae. Using a filter-binding assay a DNA-binding activity has been demonstrated which binds to a short DNA segment near the 5'end of the coding region, upstream from the transcription start of the major heat-shock genes. The binding specificity was confirmed by electron-microscopy. Possible regulatory mechanisms involved in the heat-shock response will be discussed.

5S-4,30 ORGANIZATION, DEVELOPMENTAL REGULATION AND EVOLUTION OF THE CHORION MULTIGENE FAMILIES IN INSECTS.

Kafatos, F.C. (Biological Laboratories, Harvard University, Cambridge, Massachusetts, 02138, USA)

The eggshell (chorion) proteins of silkmoths, which are produced according to a strict developmental schedule toward the end of oogenesis, are encoded by families of evolutionarily related genes (multigene families. According to the work of M.R. Goldsmith in *Bombyx mori*, these genes are highly clustered in the second chromosome. We have obtained nucleic acid probes for many of these genes by recombinant DNA procedures (cloning of double-stranded cDNA) and have characterized them in terms of evolutionary homologies and timing of expression during development. These probes have been used to study the organization of chorion genes in the genome, by selection and detailed characterization of corresponding genomic DNA clones. The results suggest possible mechanisms for the evolutionary diversification of these families and for regulation of their expression during development. Comparisons will be made between the structure and organization of chorion genes in silkmoths and in *Drosophila melanogaster*.

5S-4,31 AN APPROACH TO STUDY THE MECHANISMS OF SELECTIVE EXPRESSION OF SILK FIBROIN GENE

Suzuki, Y., Tsuda, M., Tsujimoto, Y., and Hirose, S. (Dept. Develop. Biol., Natl. Inst. for Basic Biology, Okazaki, 444 Japan)

Fibroin gene is expressed only in the posterior silk gland of *Bombyx mori* at specific stages of larval development. To understand the mechanisms of selective expression we consider controls by 1) specific gene alteration at the DNA level, 2) selective transcription, and 3) post-transcriptional processings. Analyses, in the past, of the fibroin gene and its mRNA excluded partly the controls 1) and 3). To extend the study further we have begun to apply the technics of *in vitro* genetics. "Wild type" fibroin gene has been cloned from the producer cells, and subjected to DNA sequence analysis and assignment of the transcription initiation site. From these results the DNA regions which are assumed to be important for transcriptional control have been assigned. Based on these observations, hundreds of "mutant" genes have been prepared *in vitro*. We are testing functions of the wild and mutant genes by a reconstituted *in vitro* transcription system. This approach would clarify functional aspects of DNA sequences at control regions, and help understanding the specific gene regulation. Progress on these aspects will be discussed.

5S-5,32 VISUALIZATION OF ACTIVE TRANSCRIPTION UNITS IN THE BALBIANI RINGS OF CHIRONOMUS TENTANS

Daneholt, B., Andersson, K., Björkroth, B. and M.M. Lamb, Dept of Medical Cell Genetics, Karolinska Institute, Stockholm 60, Sweden

Active transcription units on isolated fourth chromosomes from salivary gland nuclei of *Chironomus tentans* have been visualized according to the electron microscopic method developed by Miller and co-workers. These transcription units are likely to be located in the most active sites of transcription on chromosome IV, Balbiani ring 1 and Balbiani ring 2. The transcription units of these Balbiani rings generate 75 S RNA molecules, constituting putative messenger RNA species for the predominant cellular product, the salivary polypeptides. The active units most frequently observed have a mean length of 7.7 um and do not appear to be tandemly repeated. The lateral fibers on the transcription units are closely spaced with no regular pattern of gaps or evidence of processing during transcription. We have compared the active transcription units visualized by this method with the structures observed in sectioned Balbiani rings prepared for conventional electron microscopy, and with available biochemical information about 75 S RNA generated at these sites. We consider various possible models for regulation of transcription in the light of the morphology of these active transcription units.

5S-5,33 BIOCHEMICAL ANALYSIS OF DROSOPHILA MUTANTS BY MEANS OF TWO-DIMENSIONAL GEL ELECTROPHORESIS.

Hotta,Y., Mogami,K., and Fujita,S.C. (Dept.Phys.,Fac. Sci.,Univ. Tokyo, Tokyo 113 Japan)

Myogenic mutations of *Drosophila* were used to analyze biochemical links between genes and muscle development by means of O'Farrell's high resolution two-dimensional polyacrylamide gel electrophoresis (2D-PAGE) technique. Homogenates of entire adult thorax, isolated muscle and purified myofibrils were separately analyzed by 2D-PAGE. Among 200 proteins detectable in entire thorax by protein staining, about 150 were shown to exist in indirect flight muscles. Among them, twelve were identified as unique proteins of the myofibrils.

A number of myogenic flightless mutants were examined by 2D-PAGE and many were found to have abnormal gel patterns. In general, a mutation causes a few to several changes among 200 detectable proteins, mostly within the myofibrillar proteins. Methods to discriminate primary changes from secondary ones will be discussed.

5S-5,34 GENETIC CONTROL OF BODY SEGMENTATION IN DROSOPHILA AND BOMBYX BY HOMOEOTIC GENES,

Lewis, E. B. (Div. of Biol., California Institute of Technology, Pasadena, CA 91125, USA)

In Drosophila the bithorax gene complex (BX-C) controls the development of the metathorax (MT) and abdominal segments (Nature 276: 565-70, 1978). In the head, prothorax and mesothorax (MS) the BX-C genes appear to be normally repressed evidently by the product of the wild-type allele of the Polycomb (Pc^+) gene. Adults with four wings [a recently derived triple mutant hemizygous combination, *abx* bx^3 *pbx*, where anterobithorax (*abx*) is a new mutant locus, has MT virtually identical in size and structure to MS] or eight legs, or other interconversions of body segments, will be illustrated along with embryos and larvae possessing still more extreme segmental transformations. Many of these effects parallel those occurring in Bombyx mori as the result of mutants within the *E* "locus," a gene complex apparently homologous to BX-C; e.g., homozygotes for deletions of all of the BX-C genes, or homozygotes for certain extreme *E* mutants, such as E^N of Itikawa (review by Tazima, The Genetics of the Silkworm, Prentice-Hall, 1964) are embryonic lethals with thoracic-like modifications of the hypodermal, tracheal, and nervous systems of all of the abdominal segments. The BX-C complex or the E complex in Bombyx is presumably a repeated gene cluster which must have evolved before the separation of the Lepidoptera and Diptera and which may have played a major role in the evolution of the insects themselves from multi-legged ancestors.

5S-5,35 FACTORS CONTRIBUTING TO THE POLE CELL FORMATION IN *DROSOPHILA*

Okada, M. (Inst. Biol. Sci., Univ. of Tsukuba, Ibaraki 305,Japan)

At the posterior pole of a *Drosophila* embryo that has finished 9th cleavage mitoses, there are produced pole cells, a part of which develops to become germ cells. The pole cell formation is controled by activities of maternal genes; this has enabled a genetic approach to its mechanism. The *grandchildless* was first described in *D. subobscura*, and recently several mutants with similar phenotype to the *grandchildless* have been isolated and described in *D. melanogaster*. We have isolated two different *grandchildless*-type mutants, *gs(1)N26* and *gs(1)N441*. Both the mutants were inable to produce pole cells and germ cells. gs(1)N26 was different from wild type in that nuclear proliferation was asynchronous causing abnormal nuclear migration to the periphery. In *gs(1)N441* defects caused by the mutation seemed restricted to the very posterior pole.

As an different approach to the pole cell formation, we extracted RNA from embryos, which showed an activity to induce pole cells in UV-irradiated embryos. We would discuss the steps and factors involved in the pole cell formation over the available data.

5S-6,36 GERM-SOMATIC CELL RELATIONSHIPS IN THE TESTIS OF INSECT. Szöllösi, A. (UER Biol.-Zool., Université Pierre et Marie Curie, Paris, France).

Two kinds of relationships are established in the testis of insects between the germ line and the somatic tissues.

1. Germ cells, at some stages of their evolution, are associated with somatic cells. Thus, a close functional association exists between primary gonia and apical cell(s). The continued evolution of the germ line appears to depend on this relation. Later, a specific contact takes place between the sperm heads and one of the cyst cells ; this also seems necessary for the final maturation of the sperm. In both cases, there are no junctional complexes between the associated cells. In contrast, an unusual type of contact has been found recently between gonia, spermatocytes and their respective cyst wall : a true electrical coupling might be implied in this case between germ and somatic cells.

2. The existence of a " blood-testis barrier " has been demonstrated in locusts and in moths. Segregation of the germ line is brought about by the somatic envelopes of the testis where specialized junctions represent the morphological basis of this barrier. One of the main role of the somatic envelopes is to provide a microenvironment where the haploid male cells differenciate.

5S-6,37 COMPARISON BETWEEN APYRENE AND EUPYRENE SPERMATOGENESIS IN *CALPODES ETHLIUS*. Lai-Fook, J. (Dept. Zool., Univ. of Toronto, Toronto, Ontario, M5S 1A1 Canada)

Calpodes, like other Lepidoptera, produce two kinds of sperm, apyrene and eupyrene. The apyrene lack not only nuclei but also reticular and lacinate appendages. Other minor differences in axonemal and mitochondrial structure also distinguish them from eupyrene sperm in the testis, in the genital tract, and in the female. However, the two presumptive sperm can already be distinguished as secondary spermatocytes, in which the flagellum is initiated and the mitochondria accumulate in preparation for formation of the nebenkern. The nucleus of the eupyrene spermatocyte is large and spherical with finely dispersed chromatin, and becomes enveloped in an annulate lamella-like system, which may be up to 12 lamellae deep, but which lack identifiable annulae. The lamellate system remains intact throughout the subsequent division, surrounding the spindle apparatus, and becoming shared between the spermatids at cytokinesis. The nucleus of the apyrene spermatocyte, however, always remains smaller and less even in outline, has more clumped chromatin and becomes enveloped by, at most, two lamellae. At the end of meiosis, the chromosomes of the apyrene spermatid appear to remain separate and become surrounded by individual nuclear membranes thus forming many micronuclei. While the eupyrene spermatid loses much of its cytoplasm at this stage, the apyrene one appears to do so much later; the nuclei are destroyed, later also, by autolysis. The two spermatocytes remain distinguishable throughout spermiogenesis.

5S-6,38 STRUCTURE AND MORPHOGENESIS OF THE SILKMOTH CHORION. Mazur, G.D., Regier, J.C. and Kafatos, F.C. (Biological Laboratories, Harvard University, Cambridge, MA 02138, USA

Morphogenesis of the chorion in the silkmoth, Antheraea polyphemus, has been studied by a combination of morphological and biochemical procedures. The bulk of the chorion is a hardened analogue of a cholesteric liquid crystal. It consists of parallel fibrids arranged in helicoidally twisting layers, forming approximately 60 lamellae. Various modes of growth are involved in the morphogenesis of lamellar chorion: construction of an initial framework of several different types of lamellae, apparently by apposition; expansion of this loose framework by intercalation, i.e., increase in the thickness of the lamellae and the number of the fibrils while the number of lamellae remains constant and the packing density of fibrils does not change substantially; a major increase in the number of the fibrils per lamella, by intercalation; and, finally, molding of region-specific surface elaborations.

Temporal and spatial patterns of differential protein synthesis have been correlated with these morphogenetic processes. The temporal patterns suggest the probable nature of the initial framework. The composition of the region-specific surface structures is indicated by region-specific differences in protein synthesis, which are prominent towards the end of choriogenesis.

5S-6,39 THE CYTOPLASMIC ARCHITECTURE OF THE EGG CELL DURING EARLY CLEAVAGE AND POLE CELL FORMATION.

Zissler, D. and Sander, K. (Biol. Institut I, Zoologie, Universität, D-78 Freiburg, Fed. Rep. of Germany)

The egg cell cytoplasm must carry information providing the spatial coordinates or some more detailed cues for region-specific deployment of genetic information during development. In quest of such determinants of embryonic pattern formation we study the ultrastructure of insect eggs which are amenable to experimental or genetic analysis of development; we use eggs from Smittia (Chironomid.), Nasonia (Pteromal.) and Oryzaephvlus (Coleopt.). Besides providing extensive data on the overall architecture of egg cell and early embryo up to pole cell formation, our search has revealed some specialized structures but so far none of these can safely be credited with a role as cytoplasmic determinant. In this context, the question of quantitative rather than qualitative structural differences acting as regional cues will be discussed.

5S-6,40 INTERCELLULAR EXCHANGE IN VITELLOGENIC MOTH FOLLICLES.

Telfer, W. (Dept. of Bio., Univ. of Pa., Philadelphia, PA 19104 USA)

Four routes of intercellular exchange are now recognized in vitellogenic follicles of the moth, Hyalophora cecropia. (1) The oocyte and nurse cells are connected by 20-30 µm wide channels of cytoplasm. A 5 mV gradient in electrical potential is maintained across these bridges, and this is shown to polarize macromoleculat movement in the channels; microinjected acidic proteins move only from nurse cells to oocyte and basic proteins only from oocyte to nurse cells. Neutral molecules cross the channels in either direction. (2) Small molecules can move between the follicle cells and the cytoplasm of the oocyte through putative gap junctions formed at the tips of oocyte microvilli. (3) By contrast, the follicle cell product paravitellogenin is transferred to the oocyte by a combination of secretion and pinocytosis and, like hemolymph vitellogenin, is retained within the yolk speres of the oocyte. (4) Direct communication between the oocyte and the hemolymph occurs through the extracellular spaces between follicle cells. The patency of the spaces is maintained by the secretion of a sulfated proteoglycan matrix. The 4 routes have distinctive developmental histories. At the conclusion of vitellogenesis they close in a programmed sequence over a 2 day span of time, beginning with (1), followed by (2) and (4) and finally by (3). The final isolation of the oocyte from the maternal system comes with the secretion of a hydrophobic envelope.

5S-6,41 ULTRASTRUCTURE AND FUNCTION OF THE SYNAPTONEMAL COMPLEX IN BOMBYX MORI.

Rasmussen, S.W. and Holm, P.B. (Dept. of Physiol., Carlsberg Laboratory, Copenhagen Denmark)

Crossing over is absent in oocytes of Bombyx mori inspite of a normal synapsis and synaptonemal complex (SC) formation revealing at pachytene 28 bivalents each with a SC between their telomeres. Analysis of chromosome pairing in tri- and tetraploid oocytes revealed two distinct phases of the pairing process: 1) A highly specific zygotene pairing with SC formation only between homologous chromosomes or chromosome regions and 2) a correction of irregularities in this pairing by partial dissolution of the central region of the SC succeeded by a second round of SC formation permitting also nonhomologous pairing. It is conceivable that the correction of pairing is inhibited if crossing over has occured. The socalled recombination nodules which are believed to mark the positions of potential sites for crossing over and/or gene conversion are absent in Bombyx oocytes but are readily identified in Bombyx spermatocytes. After pachytene a unique ultrastructural modification of the SC takes place in Bombyx oocytes: The lateral components of SC's grow in width and in length ultimately forming a solid rod between the homologous chromosomes. These modified SC's and the attached chromatin co-orient into a metaphase plate, the modified SC's forming an almost continuous sheet, the socalled "elimination chromatin". It is likely that the preservation and modification of the SC's have evolved as a mechanism to ensure regular disjunction of homologous chromosomes in the absence of crossing over and chiasma formation. The analysis of chromosome pairing and SC formation in diploid Bombyx males have shown that interlockings are regularly present during the zygotene chromosome pairing. During early pachytene the interlockings are resolved by breakage and reunion of chromosomes or bivalents, resulting at mid pachytene in normal bivalent formation, each bivalent having a continuous SC between its telomeres.

5S-6,42 The electon-microscopic analysis of chromatin replication and transcription during early development.

Laird, C.

5S-7,43 CELL DIFFERENTIATION IN REPRODUCTIVE ACCESSORY GLANDS OF MEALWORM BEETLES. Happ, G. M. (Dept. of Zoology, Univ. of Vermont, Burlington, VT 05405 USA)

Sperm is transferred from male to female Tenebrio molitor within a spermatophore which is produced by two pairs of male accessory glands. The layered wall of the spermatophore is largely derived from secretions of the bean-shaped accessory gland. Within this gland are 7 distinct cell types, differing in the morphology of secretory granules and arranged in a regular pattern; their products form a layered semi-solid secretory plug. Each product zone remains distinct in the plug and the mass is molded to make the spermatophore during passage through the ejaculatory duct. The glands grow and differentiate over the pupal and early adult stages, passing through phases of cell division, cell growth, and peak differentiation. The control of the division of these glands will be considered as they develop in situ as well as in culture.

5S-7,44 Mechanisms of Morphogenesis of Imaginal Discs of Drosophila. Fristrom, D. (Dept. of Genetics, Univ. of Calif., Berkeley, CA 94720)

The formation of the basic shape of the adult fly occurs at the onset of metamorphosis with the remodelling of imaginal discs to form the body and appendages of the adult organism. The morphogenetic processes have been studied in leg discs, as an example of a disc which evaginates to form an appendage; and in eye discs where very precise cellular reorganization is involved in establishment of the ommatidial field. In both leg and eye discs the cellular basis of morphogenesis appears to involve a process of cell rearrangement; namely, small movements of many cells within the disc epithelium. Such movements require that individual cells change at least some of their neighbors presumably reflecting changes in intercellular adhesivity between cells.

5S-7,45

DEVELOPMENT AND ULTRASTRUCTURE OF CELLS IN THE SEX PHEROMONE GLANDS OF FEMALE LEPIDOPTERA. Percy, J.E. (Forest Pest Management Institute, Sault Ste. Marie, Canada)

The ultrastructure of sex pheromone gland cells, before and during release of the sex pheromone, is compared-using females of several species of moths. In one species, the basement membrane underlying the gland cells differs in both thickness and structure from that underlying unmodified epidermal cells. Gland cells exhibit similarities during development and maturation indicating extensive lipid metabolism. The cells from adults contain smooth endoplasmic reticulum, oval to elongate microperoxisomes and well-developed microvilli or apical folds. Lipid spheres may be stored as discrete deposits within the cuticle overlying the gland.

5S-7,46

MATURATION AND SENESCENT CHANGES IN INSECT CELLS. Sohal, R.S. (Dept. Biol., Southern Methodist Univ., Dallas, Texas, USA)

Somatic cells in the adult holometabolous insects undergo significant alterations as a result of chemo-maturation following eclosion and senescence in the postreproductive phase of life. The flight and walking activity of the housefly, *Musca domestica*, increases during the first 3-4 days and declines after 7-8 days of adult life. Immediately after eclosion there is an increase in the activity of several enzymes in the flight muscle as well as in the total volume of flight muscle mitochondria which also begins to fuse with each other to form giant but fewer organelles. The respiratory efficiency of mitochondria deteriorates in old organisms. Studies on the ageing insects indicate that there is no significant incidence of cell death with age. The most prominent ageing change is the accumulation of lipofuscin or age pigment in various organs such as brain, fat body and midgut. Lipofuscin is considered to form as a result of lipid peroxidation and autophagocytosis of cell organelles. Activity of several of lysosomal enzymes increases in the older flies. Cells of adult housefly are engaged in various forms of storage excretion. Malpighian tubules and the midgut contain concretions composed of acid mucopolysaccharides and minerals such as sulphur, phosphorous, copper, calcium, iron and zinc. The intracellular volume of concretions and the mineral content of the whole insects increases with age. The midgut cells preferentially bind copper whereas zinc primarily accumulates in the Malpighian tubules. A pteridine-like substance is progressively stored in the eyes of the housefly. The average and the maximum life span of the houseflies can be related to metabolic rate. Insects engaged in higher levels of physical activity have a relatively shorter life span as compared to the low activity flies. Studies on insect cells tend to support the free radical theory of ageing. This research was funded by US National Institute of Health grant AG171.

5S-7,47

CONTROL OF DIFFERENTIATION OF THE LEPIDOPTERAN COLLETERIAL GLAND. *Berry, S.J.* (Biology Dept., Wesleyan University, Middletown, CT 06457)

The tubular secretory segment of the colleterial gland of *H. cecropia* produces a single species of protein (m.w. 160,000) which is cross-linked by polyphenol and serves to anchor the newly-laid eggs to the surface of leaves. This secretory element is constructed from four cell-types which are produced by a series of "differentiative mitoses". Each of the cells types has a different, genetically-programmed differentiative fate. Type I produces the heavy cuticular lining of the main tubule, and shows only modest polyploidization. Type II synthesizes a thinner cuticular duct leading away from the secretory cell and also exhibits only modest polyploidy. Type III is highly polyploid and produces a pair of "pseudoflagellae" and subsequently autolyses in later stages of differentiation. Type IV, also highly polyploid, becomes the sole secretory cell. The orientation and behavior of each cell type will be discussed.

The biochemical as well as the structural differentiation of the secretory cell has been examined in detail. The temporal sequence of synthesis of the protein and the messenger RNA for the secretory protein will be discussed as well as the timing of DNA synthesis in all four cell types. Problems in the estimation of the half-life of the mRNA for the secretory protein as well as various inhibitor studies will also be presented.

5S-7,48 STRUCTURE AND DEVELOPMENT OF CATTLE TICK CUTICLE. Filshie, B. (Division of Entomology, CSIRO, Canberra, Australia)

The adult female cattle tick (Boophilus microplus) engorges about one hundred and fifty times its own body weight in blood during the last few hours of attachment to its host. The enormous increase in body size necessary to accommodate this meal is achieved by stretching and unfolding of the abdominal cuticle. The fine structure and development of the cuticle has been examined with this special requirement of extensibility in mind. The cuticle is not distinctly lamellate as are those of other arthropods and the fibrous structure is very difficult to reveal by conventional thin sectioning techniques. It has been found useful to examine this cuticle by other methods such as freeze fracturing and scanning electron microscopy of frozen fractured surfaces. The use of these techniques in combination, to solve such fine structural problems will be demonstrated.

5S-7,49 THE COMPARATIVE ULTRASTRUCTURE OF WILD-TYPE AND MALIGNANT BLOOD CELLS OF DROSOPHILA. Shrestha, R, and Gateff, E. (Biol. Inst. I, University of Freiburg, FRG).

In the larval hemolymph two blood cell-types are present, e.g., the plasmatocytes and the crystal cells. They originate from proplasmatocytes,respectively procrystal cells in the hematopoietic organs,the so called "lymph glands". The functional differentiation of plasmatocytes from proplasmatocytes involves a steady increase of cytoplasmic organelles and primary lysosomes. The increase of primary lysosomes relates directly to the phagocytic role of these cells during metamorphosis and in defence reactions.

The functional differentiation of the crystal cells from procrystal cells involves the accumulation in the cytoplasm of fibrillar material, which in fully differentiated crystal cells becomes crystalline.

Malignant plasmatocytes from recessive-lethal mutants show in situ as well as in vitro increased amounts of primary and secondary lysosomes and intense phagocytic activity.

5S-7,51 The development of the fat body.

Locke, M.

5S-8,52 Assessment of released sterile *Anopheles albimanus* and *Glossina morsitans morsitans*.

Dame, D. A. AR, SEA, USDA, P.O. Box 14565, Gainesville, FL 32604, USA

The use of the sterile insect technique (SIT) for control of vectors of malaria was assessed by a joint team from Agricultural Research (AR), SEA, USDA, and the Central America Research Station, CDC, USDHEW, working in cooperation with the government of El Salvador. A series of experiments was conducted with chemosterilized (bisazir) males of *An. albimanus* in a coastal, agricultural area. Techniques used to separate males from females in the pupal and adult stages severely reduced the competitiveness of released males and restricted the releases to only 40% (ca. 200,000 daily) of the males produced. Introduction of a genetically-altered strain (MACHO) that could be sexed in the egg stage increased the daily releases 5X to over 1 million, of which only 0.2% were females. The chemosterilized MACHO males released as pupae were highly competitive, induced significant sterility into the indigenous population, and complemented larval suppression methods used for anopheline control.

A joint team from AR and the Tanzanian Ministry of Agriculture assessed SIT for vectors of trypanosomiasis using *G. m. morsitans* reared *in vivo* in the laboratory, sterilized with gamma radiation, and released in a 200 square km test plot. Using conventional methods for initial suppression of the indigenous population and sterile males for further population reduction; ca. 85-90% control of the target species was achieved and maintained for an extended period. Although limited immigration of indigenous insects from outside the test plot prevented complete elimination of the target population, the effectiveness of integrating conventional insecticidal control with released sterile insects was demonstrated.

5S-8,53 FIELD EVALUATION OF THE EFFECT OF STERILE MELON FLY RELEASES.

Iwahashi. O. and Itô, Y. (Coll. Agr., Univ. Ryukyus, Nishihara, Okinawa, 903-01 Japan)

The sexual competitiveness of sterile flies released in a project to eradicate the melon fly from Kume Is. were estimated under field conditions. Female flies were collected both on Kume Is. where sterile flies were released and Okinawa Is. where no release was made. These females were reared individually, and eggs were collected to examine the rate of egg-hatch. Based on the ratio of females which oviposited eggs to the total number of females examined, ratios of sterile to normal females were caluculated. Substituting values of percent egg-hathc in both localities and the ratios of sterile to normal females for Haisch-Fried equation, the sexual competitiveness of released sterile flies was obtained. The value was estimated to be ca. 0.8 in January, 1975, just before the beginning of releases project. However when number of generations under mass-rearing conditions reached ca. 23 from their original parents in January, 1976, the value began to decrease, and in September, 1976 when the last infested fruit was found, it fell to 0.2. This decrease in competitiveness is considered to be mainly due to deterioration of fly stock through continued mass-rearing.

5S-8,54 RELEASES OF IRRADIATED MALES IN THE CONTROL OF GLOSSINA PALPALIS GAMBIENSIS: BEHAVIOUR OF RELEASED INSECTS.

Politzar, H., Cuisance, D., Fevrier, J., Sellin, E. (C. R. T. A., Bobo Dioulasso, Upper Volta).

Sterilized males of G. p. gambiensis released into a natural population proved to be competitive in longevity, dispersion, flight capacity and insemination ability. They succeeded under various different conditions to eradicate this population in an experimental area of about 100 skm.

5S-8,55 STERILIZATION, MASS-REARING, AND RELEASE OF STERILE BOLL WEEVILS, ANTHONOMUS GRANDIS BOHEMAN, IN AN ERADICATION TRIAL IN COTTON IN THE UNITED STATES. Wright, James E. (Boll Weevil Research Lab., USDA-SEA-AR, Miss. State, MS. 39762 USA)

Boll weevils, Anthonomus grandis Boheman, were mass reared on artificial diet with antibiotics utilizing recent advances in mechanization. Adults were held for 6 days after emergence on diet containing the insect growth regulator, diflubenzuron at 100 ppm, and then exposed to 10 Kr of gamma irradiation from a ^{137}CS source in a nitrogen atmosphere. The diflubenzuron inhibited egg hatch and development in the females, and after exposure to the gamma radiation, both sexes were sterilized. More than 12 million steriles were transported and released on 20,000 acres in an eradication trial in cotton in North Carolina. Mating performance, pheromone production of males, mortality and flight behavior were evaluated on the released steriles.

5S-8,56 Genetic sexing systems in the onion fly *Delia antiqua* and *Drosophila melanogaster*. A.S. Robinson and C. van Heemert. Association Euratom-ITAL, P.O. Box 48, 6700 AA Wageningen. The Netherlands.

Genetic sexing systems have been studied in these two species using different chemicals to selectively kill female embryos/larvae (zygotes); in the onion fly dieldrin and in *Drosophila* ethanol.
The male determining Y chromosome in *D. antiqua* comprises only 4% of the total chromosome length, this was artificially increased (by 6%) by translocating a large part of chromosome 2 to the Y chromosome. This original translocation line was fully fertile and by repeated backcrossing to a Canadian dieldrin resistant line it was made resistant to dieldrin (DD). Males from this line were irradiated (200 rad F.N.) and mated to dieldrin susceptible females (dd). The F_1 males were backcrossed and using sterility measurements new translocations both autosomal and Y-linked were isolated. As the new Y-linked translocations are inherited only by males they could be easily distinguished from the autosomal translocations. The presence of Y linked translocations was confirmed by cytological observations. Using a concentration of dieldrin which discriminates at the neonate larval stage between Dd and dd individuals linkage between the resistant gene D and the male chromosome in the new Y-linked translocations will be identified.
In *Drosophila* ADH null strains die when exposed to medium containing 4% ethanol, however, they can be easily reared in the absence of alcohol. A translocation line was obtained (Dr. B. Leigh, Leiden) which had a translocation between chromosome 2 on which the ADH locus lies and the Y chromosome; it was also ADH positive. The males were mated with females from an ADH null line and the F_1 males were again crossed to the ADH null females. Progeny from this mating were reared in 4% ethanol medium and only males emerged. It will be shown how this system can be easily modified to produce only females.

5S-9,57 CRITICAL HISTOCHEMICAL STUDIES OF BLOOD CELLS. Ashhurst, Doreen E. (Dept. of Structural Biology, St. George's Hospital Medical School, Univ. of London, Tooting, London SW17 ORE, England)

The blood cells of an insect are a very heterogeneous population. Observation with phase contrast can be used to divide the cells into categories on broad morphological criteria, but this method gives no information about the composition of the innumerable granules and globules present within many of the cells, nor of the heterogeneity which may exist within each category of cell. Questions about the composition of the granules and globules may be answered using histochemical methods. In order to avoid erroneous interpretations and conclusions, a battery of histochemical tests should always be employed.

Many of the granules in the blood cells contain complex mucosubstances. The way in which the carbohydrate moieties in these granules can be characterized histochemically will be described and the pitfalls inherent in the interpretation of the commonly used tests will be illustrated. Similarly, the methods by which the lipids in droplets within the cells can be characterised will be described. Enzyme histochemistry of blood cells has received less attention. Hydrolytic enzymes can be located within some blood cells. The application of enzyme histochemistry to blood cells will be discussed.

The aim of this paper is not to give an exhaustive account of the histochemistry of blood cells, but, using a few blood cells as examples, to illustrate the pitfalls which can be encountered in a histochemical study.

5S-9,58 CELLULAR DEFENSE REACTIONS OF DROSOPHILA LARVAE TO HYMENOPTEROUS PARASITOIDS

Carton, Y., (Lab. Biol. Gen. Evol., CNRS, 91190 Gif, France) ; Brehelin, M. (Lab. Path. comp., Univ., 34060 Montpellier, France) ; Kitano, H. (Dept. Biol. Tokyo Gakugei Univ., Tokyo, Japon).

Cothonaspis boulardi (Hymenoptera, Cynipoidea Eucoilidae) is an endoparasite of Drosophila species. It can be reared on D. melanogaster larvae but never hatches from eggs laid in D. yakuba larvae. The eggs in D. yakuba are almost always encapsulated.

In contrast with what happens in several Drosophila species (e.g. D. melanica group) the capsules developed in D. yakuba are made of hemocytes (lamellocytes ?), which rapidly establish desmosome-like junctions. In the outer zone of the capsules, hemocytes are quite alive, those of inner layers are necrotic cells which seem to constitute melanotic zones. In D. yakuba we can show that the transformation of plasmatocytes into lamellocytes is enhanced in the case of superparasitism (2 eggs per host).

In D. melanogaster, C. boulardi eggs are not encapsulated, however, we cannot observe virus-like particles around the parasite eggs laid in larvae of D. melanogaster and within the ovaries of the parasite.

5S-9,59 THE HEMOCYTIC ENCAPSULATION OF HETEROXENIC NEMATODES IN THEIR INSECT INTERMEDIATE HOST : AN ADAPTATIVE PROCESS.

Seureau, C. (UER Biol. - Zool., Univ. Pierre et Marie Curie, Paris, France)

The life cycle of the heteroxenic nematodes, including the well known filarial nematodes, requires both an insect intermediate host and a vertebrate definitive host. In the insect the first stage larvae of all these parasites actively cross the midgut epithelium. The cellular reactions of the insect host to the parasite differ, according to the taxonomic position of the nematode, by the nature of the affected cells and their localization in the organism.

In case of the subulurid nematodes, the parasite larvae are encapsulated by hemocytes as soon as they reach the hemocoele. Within the hemocytic capsule, the nematodes develop to the infective third stage juvenile and then remain in quiescent state until the insect is ingested by the appropriate definitive host. The hemocytic encapsulation occurs without melanization. It involves neither degeneration nor death of the nematode. Thus the parasite is first recognized as foreign by the host which sets in motion its cellular defense reaction, and then obviously protected by this defense reaction.

This uncommon aspect of the hemocytic encapsulation represents a good adaptation between the parasite and its host. It should still be considered as relatively primitive when compared with the other cell reactions caused by heteroxenic nematodes in their insect intermediate host.

5S-9,60 Host Immune Responses to Parasitoids and the Role of Symbiotic Viruses.

Vinson, S. (Dept. Ent., Texas A&M Univ. College Station, Texas 77843 (USA).

Evidence will be presented showing that viruses associated with the reproductive system of certain parasitoids in the Braconidae and Ichneumonidae are necessary for the evasion of the host defenses. Evidence will also be presented to show that the virus prevents encapsulation through its effect on host tissues other than a direct effect on the hemocytes involved in encapulation.

5S-9,61 Role of hemocytes in the synthesis of hemagglutinins and other immunologic factors.

Amirante, G. A.

5S-10,62 CHEMISTRY, SPECIFICITY, AND MODE OF ACTION OF THE PRECOCENES. Bowers, W.S.

Structure and biological activity relationships of the precocenes indicate that they undergo bioactivation by the formation of "reactive" epoxides which alkylate discrete cellular elements resulting in allatal cell death. The basis of precocene specificity will also be detailed.

5S-10,63 BIOCHEMICAL CONTROL OF JUVENILE HORMONE BIOSYNTHESIS. Kramer, Steven J., Monger, Daniel J. and Law, John H. (Dept. Biochem., Univ. Chicago, Chicago, IL., U.S.A.)

Juvenile hormones share with other isoprenoids a biosynthetic pathway leading through mevalonic acid. The enzyme, 3-hydroxy-3-methyl glutarylCoA reductase (HMG CoA reductase), is responsible for the production of mevalonic acid, and in the case of cholesterol biosynthesis in mammals, the activity of the enzyme limits the rate of sterol production. In homogenates of corpora allata of the tobacco hornworm, *Manduca sexta,* HMG CoA reductase levels parallel closely the rate of juvenile hormone production in all life stages except the adult male, in which enzyme levels are high, but hormone production by glands cultured *in vitro* is unmeasurable. It is possible that under most conditions levels of HMG CoA reductase limit the rate of juvenile hormone synthesis in corpora allata. Supported by a grant from the U.S. Public Health Service, GM 13863, and a National Research Service Award, ES 05160.

5S-10,64 REGULATION OF JUVENILE HORMONE BIOSYNTHESIS BY THE CORPORA ALLATA OF ADULT DIPLOPTERA PUNCTATA. Tobe, S.S., Stay, B., Friedel, T. and Feyereisen, R. (Dept. Zool., Univ. Toronto, Tor. M5S 1A1, Ont. Canada). The corpora allata (CA) undergo predictable and reproducible changes in juvenile hormone (JH) synthesis during the gonotrophic cycle of the viviparous cockroach Diploptera punctata. These changes indicate that the CA are regulated precisely in this species by intrinsic factors probably of both humoral and "nervous" natures. Studies on feedback regulation of the CA have shown that experimental alterations in JH titres, either above or below the set point, alter JH synthesis. These responses suggest the existence of both allatotropic (CA stimulatory) and allatostatic (CA inhibitory) substances. The effects of these substances appear to be mediated through the CNS because they cannot be duplicated in vitro. 20-hydroxyecdysone also appears to be a regulator of JH synthesis, inhibiting JH synthesis in a dose-dependent fashion. This inhibition can occur at any time during the gonotrophic cycle although maximal inhibition occurs during the second half of the cycle at a time when 20-hydroxyecdysone appears in the haemolymph (see Stay et al., this meeting). It appears that 20-hydroxyecdysone is an intrinsic regulator of JH synthesis and is responsible in part for the decline in JH synthesis at the end of the gonotrophic cycle.

5S-10,65 REGULATION OF LARVAL DEVELOPMENT BY JUVENILE HORMONE. Riddiford, L. M. (Dept. Zool., Univ. Wash., Seattle, Wash., U. S. A.)

An insect larva such as the tobacco hornworm Manduca sexta is comprised of a mosaic of tissues with differing requirements for the regulatory action of juvenile hormone (JH). There are strictly larval tissues such as the crochet epidermis which makes the black hooks on the abdominal prolegs, then dies when JH is withdrawn at metamorphosis. The abdominal epidermis by contrast is capable of producing either a larval or a pupal cuticle depending on the presence or absence of JH at the time that it is exposed to ecdysteroids. The imaginal anlage depend on JH for a slow continuous growth, then as the hormone titer declines during the last larval instar become competent to respond to ecdysteroids with the production of pupal cuticle. Later during the prepupal period they require JH again to prevent precocious adult differentiation. These differing sensitivities to JH are dramatically illustrated by crochetless supernumerary larvae with pupal eyes and tanned uneverted pupal wing discs produced by exogenous JH application to mid-feeding stage final instar larvae before the first ecdysone release for metamorphosis.

A tissue may also have differing temporal needs for JH. Thus the general body epidermis requires the hormone at the time of exposure to ecdysteroids in order to produce a larval cuticle. Then about 18 hrs later JH is again necessary, this time to prevent melanization of the new larval cuticle and the subsequent production of an ommochrome pigment by the epidermal cells after ecdysis.

The regulatory action of JH in these various tissues and within one tissue at different times will be discussed. (Supported by grants from NSF, NIH, and USDA)

5S-10,66 REGULATION OF THE LARVAL CORPORA ALLATA OF THE TOBACCO HORNWORM (MANDUCA SEXTA). Granger, N.A., Bollenbacher, W.E., and Gilbert, L.I. (Dept. Biol. Sci., Northwestern Univ., Evanston, Illinois, U.S.A. 60201)

An in vitro method has been developed for the investigation of the regulation of corpora allata, which utilizes radioimmunoassays (RIAs) specific for JH I and JH III to measure JH biosynthesis by glands from Manduca sexta larvae. The JH I RIA is specific for JH I and exhibits approximately 12.6% cross reactivity with JH II and no cross reactivity with JH III. The JH III RIA has approximately 7% cross reactivity with JH II and no cross reactivity with JH I. Both assays directly measure JH present in culture medium and have a maximum sensitivity of 50 pg JH equivalents. The kinetics parameters for the in vitro system were defined for corpora allata and brain-corpora cardiaca-corpora allata complexes from penultimate and last instar larvae and early pupae, and JH biosynthesis was found to be linear for at least 6 hr in each case. Both complexes and corpora allata from the different developmental stages exhibited JH I synthesis rates generally consistent with predicted activity based on in vivo hormone titers. However, the fluctuations in the biosynthetic activity of the complexes were more pronounced than those of the isolated glands, suggesting that presence of the brain affects gland activity. Preliminary evidence to support this supposition will be presented. Significant amounts of JH III were also made by the corpora allata in vitro, with developmental fluctuations in the rates of synthesis paralleling those of JH I. Although appreciable titers of JH III have thus far not been found in the hemolymph during larval development, undoubtedly because of catabolic effects, the larval CA nevertheless do synthesize this homolog.

5R-1,1 ECDYSTEROIDS IN OVARY AND HEMOLYMPH OF THE COCKROACH, DIPLOPTERA PUNCTATA.
Stay, B. (Zool., Univ. Iowa, Ia. City, Ia. U.S.A.), Friedel, T., Feyereisen, R., and Tobe, S. (Zool., Univ. Toronto, Toronto, Ontario Canada)

Liquid high pressure chromatographic analyses of extracts from ovaries and hemolymph during the first vitellogenic cycle show much ecdysterone in the ovary (20 ng/mg fresh ovary) at the end of vitellogenesis, day 7 at 27°C. One day earlier ecdysterone in the hemolymph increases from 0.5 to 1.3 ng/µl, and disappears at the time of ovulation. Injections of ecdysterone (5-10 µg/animal) depress the rate of juvenile hormone (JH) synthesis by the corpora allata of vitellogenic females. These observations suggest that the ovarian influence on the rate of JH synthesis, demonstrated previously (Stay and Tobe 1978, Gen. comp. Endocrinol. 34:276-286; Stay et al. 1980 Science in press), is mediated by ovarian ecdysterone.

5R-1,2 ECDYSONE TITRES DURING POSTEMBRYONIC DEVELOPMENT IN SARCOPHAGA BULLATA (SARCOPHAGIDAE: DIPTERA). Roberts, B., Wentworth, S.L. and O'Connor, J.D. (Zool. Dept, Monash Univ., Clayton, Vic. 3168, Australia)

The levels of ecdysone in Sarcophaga bullata were determined by a radioimmunoassay in larvae, prepupae, pupae and pharate adults from the time of larviposition until adult eclosion. In the larval period of development three distinct releases of ecdysone were recorded; the first two at 14h and 30h resulted in larval/larval moults while the third, which commenced at 131h, resulted in pupariation. White puparium formation occurred at 144h.*

In the prepupal, pupal and pharate adult stages of development three distinct peaks of ecdysone were recorded. The first (18h) was of short duration and directed tanning of the puparium, larval/pupal apolysis and pupal cuticle secretion. The second release (70-120h) was sustained and resulted in pupal/adult apolysis and the definition of adult form while the third release (160-180h) directed the synthetic activity of cuticle secretion. The significance of these releases of ecdysone will be discussed.

* The formation of the white puparium was selected as 0h for prepupal, pupal and pharate adult development.

5R-2,3 Genetic sexing and alcoholdehydrogenase in insect control, Heemert, C. van and Robinson, A.S., ITAL, P.O. Box 48, Wageningen, the Netherlands

The use of the sterile insect release method (SIRM) to control large medfly populations is becoming more important. Development of a genetic sexing mechanism in order to produce only male progeny would be an enormous help to avoid the sterile sting problem and to reduce rearing costs. Further, monitoring the population in the field after release will be much easier in the case when only sterile males are released.

The development of a genetic sexing mechanism depends on two factors, first the isolation of a conditional lethal and secondly the induction of a Y-linked translocation linked with the autosome carrying this mutant.

Since the use of the alcoholdehydrogenase (ADH) gene has been suggested as well as the use of an insecticide or temperature sensitive trait, electrophoresis studies have been initiated. The medfly strain from the IAEA has been shown to have only one ADH pattern. However, recently a strain from the field (Spain) was introduced and a new ADH allele was observed. We are now underway to isolate a mutant line of this new allele. Subsequently irradiation will be carried out to induce a suitable Y-linked translocation. An other approach which is being carried out is the procedure to isolate ADH null-mutants with the use of pentanol a toxic alcohol for ADH positive flies. Using *Drosophila* a discriminating dose between the ADH positive flies and the flies heterozygous for the null allele will be identified. This dose will be extrapolated to the medfly where following E.M.S. treatment F_1 individuals will be treated with pentanol to select the heterozygous null flies.

5R-2,4 Experimental eradication of Glossina palpalis gambiensis by an assoziation of a chemical with a genetic method. Politzar H., Cuisance D., Fevrier J., Sellin E., C.R.T.A. (I.E.M.V.T - GTZ), Bobo Dioulasso, Upper Volta

After experimental variation of different parameters an interesting synergy of an application of non persistant insecticide, followed by inundative releases of sterile males was found. Eradication of this veterinary and medically interesting species has been achieved in an area of approximately 100 km^2.

5R-2,5 EFFECTS OF THE CHEMOSTERILANT THIOTEPA ON THE ADULT VIVIPARAE OF THE PEA APHID ACYRTHOSIPHON PISUM (HARRIS) AND THEIR FILIAL GENERATIONS. Sharma, M.L.; Thériault, L.M. (Dép. de biologie, Faculté des sciences, Université de Sherbrooke, Sherbrooke, P.Q., Canada, J1K 2R1

The adult viviparae of the pea aphid Acyrthosiphon pisum (Harris) when treated with 0.5 thiotepa for 2 hours, reproduced 7 to 9% less. However the fecundity of F_1 generation diminished from 41 to 66% (average of 51%) and that of F_2 up to 84% in its early stage. The fecundity of late F_2 and F_3 was normal. A longer contact with thiotepa (4 hours) resulted in greater decrease in fecundity. The fecundity of treated parents diminished by 56% and that of F_1 up to 84-91%. After this high decrease in F_1 generation the recovery towards normal fecundity was attained in late F_3 generation. Thiotepa contact caused total sterility of 6-17% of aphids in either the F_1 or early F_2 generation.

5R-2,6 MED-FLY CELL LINE: RESPONSE TO IRRADIATION WITH FAST NEUTRONS AND GAMMA RAYS. Cavalloro,R., Coppola,M. and Pozzi,G. (Commission of the European Communities,Biology, J.R.C., 21020 Ispra (VA) Italy.

Differential sensitivity of biological systems to various radiation qualities has been observed in many experimental trials. In general, fast neutrons and gamma rays have proved to produce biological responses which can be largely different; in particular, the relative response is depending on the dose level of radiation applied. In this context Med-fly, Ceratitis capitata Wied., cells have been tested by observation of cell population growth and cell mortality.

Med-fly cell line has been established only recently (Cavalloro, 1979) and it represents a step forward to the solution of important agricultural and economical problems related to this very harmful species.

Fast neutrons of 1.5 and 16 MeV were produced by a Van de Graaff KS 3000 accelerator, whereas ^{60}Co gamma rays irradiation was performed using a 220 Gammacell apparatus: neutron doses ranged between 1.5 and 25 rad, for the gamma rays dose values between 300 and 5000 rad were used. The experimental results show much higher radiosensitivity of these cells to fast neutrons relative to gamma ray radiation, and a clear dependence of the RBE values on neutron-dose levels. Furthermore, a certain influence of radiation quality was observed for the cellular damage. Dose-effect relationships are analyzed for both neutrons and gamma rays and results are discussed.

5R-3,7

MICROSCOPIC STUDIES ON THE EMBRYOLOGICAL DEVELOPMENTS OF EGGS OF TICKS OF VETERINARY IMPORTANCE IN NIGERIA. *Dipeolu*, O.O. (Fac. Vet. Med., Univ. Ibadan, Nigeria)

The embryological development of eggs of several ticks feeding on livestock in Nigeria was studied and compared. These ticks include *Amblyomma variegatum*, *Boophilus decoloratus*, *B. geigyi*, *Hyalomma rufipes*, *H. truncatum*, *H. impressium*, *H. impeltatum*, *Rhipicephalus sanguineus* and *Haemaphysatis leachi leachi*. Detailed results and descriptions will be presented at the Congress.

5R-3,8

DEVELOPMENT OF MALE SEX CELLS IN THE SWALLOWTAIL, *PAPILIO XUTHUS* L. IN RELATION TO PUPAL DIAPAUSE. Numata, H. (Dept. Zool., Kyoto Univ., Kyoto, 606 Japan)

The induction of diapause in the pupa of the swallowtail, *Papilio xuthus* L. is mainly controlled by photoperiod during the larval stage: the larvae developing under a short photoperiod are destined to become diapausing pupae. Pupal diapause has been characterized, in part, as involving an inhibition of spermatogenesis. Testicular development and spermatogenesis were studied in *P. xuthus* larvae and pupae of both diapause and non-diapause types. The prompt differentiation of the sex cells was observed during fourth and fifth (final) instar larvae, and eupyrene sperm bundles were first observed on first day of fifth instar in both types. In the diapause type, the spherical spermatids began to degenerate at this stage, and on fourth day of fifth instar the spermatogenesis stopped completely, and degeneration occurred in all the spermatidal cysts and sperm bundles at pupal stage. In the non-diapause type, however, spermatogenesis proceeded on throughout fifth instar, and apyrene sperm bundles appeared in pupae. After the termination of diapause and the initiation of adult development in diapausing pupae, eupyrene sperms developed *de novo* from spermatogonia and spermatocytes, followed by development of apyrene sperms.

5R-3,9

STRUCTURE AND FUNCTION OF CELLS ACCESSORY TO SPERM MATURATION IN LEPIDOPTERA.

Shepherd, J., Rader, F., Welsh, A., and Turner, P. (Biology Dept., State Univ. of New York, Binghamton, NY 13901, USA)

Several kinds of cells in the male reproductive tract of Lepidoptera play accessory roles in sperm maturation and maintenance. This study reports on some aspects of the ultrastructure of the apical cells and cyst-cells of the testis, and on the biochemistry of secretions produced by cells of the accessory glands in the tobacco hornworm moth *Manduca sexta*. Electorn micrographs of apical cells (one per testicular follicle) show a very large cell with a large central mass of electron-dense material and with extensive interdigitations with adjacent spermatogonia. Ultrastructural studies of the cyst-cells have focused on their role in the release of the mature sperm bundles from the testes: the cyst-cells containg sperm bundles appear to insert into the "basilar membrane" separating the testicular cavity from the lumen of the vas efferens. Membrane junctions between the cells of the "basilar membrane" and the cyst-cells appear to maintain the isolation of the testicular cavity from the vas efferens while allowing exit of the bundles. Biochemical studies of the secretions of the accessory gland cells support previous ultrastructural observations that a glyclgen-like polysaccharide is a major product of these cells. This polysaccharice later breaks down when the spermbecome motile in the spermatophore.

5R-3,10 CHANGES IN AMINO ACID INCORPORATION DURING EMBRYOGENESIS OF *BOMBYX MORI*.

Kawaguchi, Y., Fujii, H., Koga, K. and Sakaguchi, B. (Fac. Agric., Kyushu Univ., Fukuoka, 812 Japan)

Biochemical studies on the embryonic protein synthesis of *B. mori* has suffered a disadvantage due to the rigid egg shell. We tried to overcome this difficulty applying a simple microinjection technique as has been reported for RNA synthesis in *B. mori* eggs (Kurata, Koga & Sakaguchi, Chromosoma, 68, 313, 1978). As the first study along this line we labeled eggs by ^{3}H-leucine (110 Ci/mmol) for 6 h, and the label was counted in the total acid insoluble fractions. Eggs deposited within 1 h and kept at 25^{o}C for up to 10 days were used. Design was made to compare normal embryogenesis with that of a mutant kidney shaped eggs (*ki*), which differentiate only incomplete ectodermal tissues and can not hatch. A part of hibernating eggs were treated with hot HCl at the early germ band stage in order to obtain artificial non-diapause eggs. Results show that the amount of incorporation of ^{3}H-leucine changed during development in all the samples tested. However the data were not normalized for the possible changes in active amino acid pool and the significance of the pattern has not been established, we infer that the fluctuation of incorporation mirrors the changes in protein synthetic rate in the eggs at least to a certain extent because of the following findings: (1) The incorporation became most intensive after the onset of organogenesis in the normal (+^{ki}), artifical non-diapause eggs. (2) The incorporation during organogenesis was partly inhibited by injecting actinomycin D (AMD). (3) In the *ki* eggs, the incorporation remained low during the period when organogenesis would occur normally. (4) During diapause no incorporation was observed. It is worth noting that a peak of "AMD-resistant" ^{3}H-leucine incorporation was seen during the early germ band stage when RNA synthesis is low (Kurata, Koga & Sakaguchi, Insect Biochem., 9, 107, 1979).

5R-4,11 EFFECTS OF THREE LARVAL DIETS ON THE DEVELOPMENT OF THE ARMYWORM, *SPODOPTERA LATIFASCIA*.

Habib,M.,Paleari,L. and Amaral,M.(Dept.Zool,State Univ.Campinas,Campinas,SP,13100,Brazil)

Populations of *Spodoptera latifascia* were normally observed in very low densities in some economic plantaions in Brazil. Recently, severe outbreaks were detected. The present work treats with the effect of three larval diets, cotton, soybean and lettuce leaves, on the development of *S.latifascia*. The approximate digestibility, larval and pupal duration times, adult longevity and reproductive capacity were the parameters used to evaluate the suitability of the larval diet.

Cotton leaves showed more suitability and nutritive quality than the other two diets. Lettuce leaves did not sustain the larval development and had an excellent role as stressor and as activator of latent nuclear polihedrosis in the larvae.

5R-4,12 REGULATION OF BODY SIZE DURING NYMPHAL DEVELOPMENT IN THE GERMAN COCKROACH (*BLATTELLA GERMANICA*).

Tanaka, A. (Dept. Biol., Nara Women's Univ., Nara, 630 Japan)

It may be important for insects to attain a certain standard size when they reach adult. It has been shown that insects do not simply count instars but may have some regulatory mechanism to attain the adult size. Recent studies have demonstrated that the process for adult is initiated only when a critical size is attained. It has been revealed, however, that there may be another type of regulation of body size during nymphal instars in the German cockroach. Head width and some other characteristics were measured after fixation in every nymphal instar to adult. The distribution of measured body size clearly separated into two groups, a small group and a large one, in the 5th instar and even in the 4th instar. This suggests that a nymph has already determined the number of following molts by the late 3rd instar. Also, nymphs hatched from a single ootheca were isolated alone just after hatching, and all the individuals were measured after Co2 anesthesia in every successive instar until adult. Among individuals which required the same number of instars to reach adult, the coefficient of variation of body size decreased as the stage advanced after the 4th instar and the value became the smallest in the adult in both males and females. Moreover, smaller individuals at the beginning in a certain instar tended to grow more than larger ones during the instar. These results suggest that a nymph measures its own absolute size by some mechanism, which is still unknown, during nymphal development and regulates its body size and the number of nymphal instars in order to attain the "norm" of adult size.

5R-4,13 GENETICS OF ELYTRAL PATTERN IN THE COCCINELLID *COELOPHORA INAEQUALIS* (F.). Hales, D.F. and Houston, K.J. (Sch. Biol. Sci., Macquarie Univ., North Ryde, N.S.W., 2113, Australia)

Eight alleles controlling elytral pattern in the coccinellid *Coelophora inaequalis* (F.) have been characterised in studies of populations on the east coast of Australia. The alleles in homozygous condition produce the following patterns: $\underline{c}^{y}$ = yellow, $\underline{c}^{s}$ = nine-spotted, $\underline{c}^{v}$ = striped, $\underline{c}^{n}$ = pattern of typical *C. inaequalis*, $\underline{c}^{f}$ = similar to $\underline{c}^{n}$ but with fusion of spots, $\underline{c}^{h}$ = similar to $\underline{c}^{n}$ but pigmented area greatly increased, $\underline{c}^{z}$ = spots fused in a zig zag arrangement and $\underline{c}^{b}$ = elytra entirely black. The alleles exhibit mosaic dominance. Allelic frequencies have been calculated for three widely separated regions.

5R-5,14 GENE LOCI OF SERICIN SYNTHESIZED IN THE SILK GLAND OF *BOMBYX MORI*. Gamo, T. (Dept. Silkworm Breeding, Sericult. Ext. Stn., Yatabe, Ibaraki 305, Japan)

Sericin proteins can be displayed as five main polypeptides secreted from the different sections of the middle silk gland by gel electrophoresis containing 4 M urea. Some variant polypeptides of sericin with different mobility were found and analysed genetically. A variant sericin (S-2^{v}) which has been found from a 'Sericin-cocoon' strain originated in Burma was clarified to be controlled by a co-dominant allelic gene to the *Src-2* for S-2 sericin secreted from the anterior section of the middle gland and named *Src-2*^{v}. Linkage analysis showed that this gene locus is located at 0.0 map unit on chromosome 11. The molecular weight of S-2^{v} sericin was smaller approximately 5.5×10^{4} daltone than that of S-2, although the amino acid composition of the both sericins is similar. Therefore, the *Src-2*^{v} allele can be considered to be approximately 1.3 Kb shorter than the *Src-2*, and perhapse this variant was arisen by unequal crossing over. The *Src-2* allele further is not linked with the genes controlling other polypeptides of sericin, so that the gene loci of sericin in *Bombyx* can be considered to be distributed on many different chromosome.

5R-5,15 The Distribution of Hemoglobin Genes in Chironomus. Laufer, H.[1], Kuliawat, R.[1], Gundling, G.[1], and Ramirez, F.[2] [1]Biol. Sci. Group, Univ. of Connecticut, Storrs, [2]Rutgers Med. School Piscataway, N.J., U.S.A.

Larval Chironomus thummi have multiple molecular forms of hemoglobins (Hbs) in their hemolymph as revealed by acrylamide gel electrophoresis. These proteins are well characterized (mol wt 15-16,000), several have been sequenced. They are synthesized by the fat body (Laufer et al, 1976) and are regulated by the hormones, ecdysterone and juvenile hormone. Using *in situ* hybridization to polytene chromosomes with labelled single stranded complementary DNA (c-DNA) we are localizing Hb genes to learn more about their genetic distribution and organization. Hb m-RNA was purified from C. thummi by repeated phenol extraction, oligo dT cellulose chromatography, and DMSO-sucrose density centrifugation. Following wheat-germ cell-free translation, five proteins were resolved in SDS-acrylamide gels which comigrated with Chironomus globin. These proteins were quantitatively precipitated by antibodies specific to Chironomus Hbs. Single stranded c-DNA (14,000CPM/ng) to Hb m-RNA was hybridized to C. thummi, and C. decorus (carensis), two similar species. Five bands were labelled consistently, 2 localizing in a double band on chromosome II and 3 on the left arm of Chromosome III. These correspond to positions II-F 1-2 for the doublet in the C. thummi map of Laufer and Holt 1970, and to positions III C 2b, III D1d, and III D2f. C. decorus (carensis) have 5 similar signals. In addition, C. thummi gave several weak hybridization signals in positions III D1e, C4g, and B1. The same doublet labelled on chromosome II in C. tentans and C. pallidivittatus. Tichy (1970, 1975) using genetic mapping, approximated the localization of "species specific" Hb genes to the left arm of C. pallidivittatus (Chromosome III homologus to the left arm of III in C. thummi), providing an independent localization for 3 Hb genes. The other two bands represent "non-species specific" loci. Our results represent one of the first successes at localizing genes by *in situ* hybridization for specific proteins regulated during development with known functions and amino acid sequences. (Supported by grants from the NSF and Univ. of Connecticut Research Foundation).

5R-5,16 TRANSFER RNA OF ITS GENE OF Nd SILKWORM. Matsuzaki, K.(Dept. Chem. Ser. Except. Station, Ibaragi, 300-21 Japan)

In order to clarify mechanism that fibroin synthesis has been inhibited in the posterior silkgland of naked pupa(symborized as Nd), the amino acid acceptor activity and the electrophoretic patterns of tRNAs from the normal posterior silkgland producing fibroin and from the posterior silkgland of Nd silkworm which secretes little fibroin are compared. The tRNA from the normal silkgland incorporated much $[^{14}C]$-glycine and $[^{14}C]$-alanine and less $[^{14}C]$-leucine and $[^{14}C]$-lysine, which reflects the amino acid composition of fibroin. However, with silkgland tRNA of Nd silkworm, it was not observed but there was incorporation of considerable amounts of various amino acids. In case of two-dimensional polyacrylamide gel electrophoresis of silkgland tRNA of Nd silkworm, fewer isoacceptors were recognized compared with tRNA from the normal silkgland, especially regarding isoacceptors of glycyl-, alanyl-, and seryl tRNAs. Furthermore, DNA and aminoacyl tRNA were prepared from both silkglands and hybridized each other.

5R-5,17 DEFICIENCY IN XANTHINE DEHYDROGENASE ACTIVITY IN THE OILY MUTANTS OF THE SILKWORM,BOMBYX MORI. Tamura,T. (Sericul.Exp.Sta.,Yatabe,Ibaraki 305,Japan)

The larval integument of the normal silkworm is usually opaque and white, but those of the several mutants which are called the oily silkworm are translucent. Up to date, more than 35 different kind of oily mutant genes have been reported. In this study the relationship between the mechanism of the expression of the oily mutant gene and the activity of xanthine dehydrogenase was investigated. The three oily mutant strains, og, og^t and oq mutants, were used for the determination of the activity of xanthine dehydrogenase and of the amounts of hypoxanthine, xanthine, and uric acid. Xanthine dehydrogenase activity of the fat body was considerably high in the normal larva and adult, but was almost negligible in all of the three mutants. A large amount of uric acid was contained in the feces and the integument of the normal larva, but xanthine and hypoxanthine were scarcely detected. However, a large amount of hypoxanthine or xanthine occured in the feces, in the blood, and in the meconium of these oily mutants , whereas uric acid was not detected. It was concluded that the og, og^t and oq genes induced the deficiency of xanthine dehydrogenase activity, and that the supression of the formation of uric acid resulted in the translucent larval integument of these three mutants.

5R-6,18 FINE STRUCTURE OF THE WAX GLAND IN A SCALE INSECT, ERIOCOCCUS LAGERSTRAEMIAE. Waku, Y. and Manabe, Y. (Biol. Lab., Kyoto Tech. Univ., Kyoto 606 Japan)

Dorsal surface of E. lagerstraemiae is covered by the thick waxy substance woven from thin tubular filaments. The integumentary wax glands secreting those filaments distribute throughout the dorsal surface of the body. Light and electron microscopy reveal that the gland is composed of one main cell, six lateral cells and one duct cell. The main cell stores massive secretory substance in its large reservoir. The secretory substance shows positive reactions of lipids, proteins and carbohydrates. Cytoplasm of main cell contains well-developed rough-surfaced endoplasmic reticulum, mitochondria and numerous secretory globules which are discharged into the lumen of the reservoir. The lateral cells may also contribute some secretion(s) to the covering substance, but their precise role is unknown. The duct cell contains a cuticular ductule which is formed by the cell itself. The formative mechanism of the tubular filament is of special interest. The amorphous secretory substance is transported from main cell to the aperture of the gland via ductule, and then is molded as a tube by the trough-shaped cast cuticle present at the aperture.

5R-6,19 ULTRASTRUCTURE OF DEVELOPING CHORDOTONAL SENSILLA,OLFACTORY ORGAN AND THEIR NERVES IN THE LABIAL PALP IN *Pieris rapae* L. *Kim*, Chang-Whan and Lee, Chong-Kyu(Dept. Biol. Korea Univ., Seoul, 132, Korea)

Development of the olfactory organ on the palpal epidermis and of the chordotonal sensillium in the tip of the palp and growth of their nerves in the palp were observed in *Pieris rapae* using light microscope by one of the present authors(Kim, 1961). Ultrastructural changes of the chordotonal sensillium which is uncertain in the origin, presumably derived from the existing primordial cell in the larval palp prior to differentiation of the olfactory placode and also fine structure of the developing olfactory organ elements on the epidermis during the prepupal stage have been persuaded by using electron microscope.

5R-6,20 MORPHOLOGY AND HISTOLOGY OF THE CEPHALIC ENDOCRINE SYSTEM OF THE LARVAL AND PUPAL GYPSY MOTH, *PROTHETRIA DISPAR* (L). Yin, Chih-Ming, (Dept. of Ent., Univ. of Mass., Amherst, MA USA)

The cephalic neuroendocrine structures and related nerves of the larval and pupal gypsy moth, *Prothetria dispar* (L) were examined. The forms, anatomical relationships and histology of the brain, corpora cardiaca, corpora allata and prothoracic glands were studied. Significant differences were detected between the larval and pupal systems.

5R-7,21 COMPARISON OF THE *IN VITRO* ACTIVATION PATTERNS OF PROTHORACIC GLANDS BY PROTHORACICOTROPIC HORMONE (PTTH) IN THE THREE SPECIES OF LEPIDOPTERA. *Agui,N., Bollenbacher,W.E., Granger,N.A. and Gilbert,L.I. (*Dept. Med. Ent., Natl. Inst. Health, Tokyo 141 Japan, Dept.Biol. Sci., Northwestern Univ. Evanston, Ill, 60201 USA)

Time course of ecdysone synthesis *in vitro* for PTTH activated and nonactivated day 0 pupal prothoracic glands (PG) was compared among the three species, tobacco hornworm (*Manduca sexta*), the cabbage armyworm (*Mamestra brassicae*)and the silkworm (*Bombyx mori*)by the methods combining the organ culture of PG with ecdysone radioimmunoassay. The PGs cultured in the medium with the homogenate of brains from the same species were activated maximally about 4 times at 6hr after onset of culture in *Manduca*, 10 times at 4hr in *Bombyx* and 7 times 1hr in *Mamestra* respectively.

Dose-response of PG activation was also examined for the homogenate of day 0 pupal brain of the same species and the amount of PTTH activity was expressed by using brain equivalent necessary to elicite half maximal activation (A_{50}) according to the obtained dose response curve. A_{50} is 0.16 brain equivalent in *Manduca*, 0.34 in *Bombyx* and 1.0 in *Mamestra* respectively. While, the PG culture with the homogenates of the brains from the other species were activated as well as those cultured with the brain homogenates from the same species.

These results indicate that in lepidopteran insect the PGs may be able to activated by PTTH over speices, in other words, PTTH originating from different species has ability to activate the PGs from the other species. Furthermore, it is ascertained that this *in vitro* system is very useful as a rapid reproducible and accurate assay method for PTTH.

5R-7,22 ROLE OF BRAIN IN THE CONTROL OF JH ESTERASE ACTIVITY IN GALLERIA MELLONELLA LARVAE.

Kumaran, A.K. and McCaleb, D.C. (Dept. of Biol., Marquette Univ., Milwaukee, WI 53233, U.S.A.)

Juvenile hormone specific esterase(s) (JHE) appears in the hemolymph of last instar larvae about half way through the last larval stadium. The enzyme seems to play an important role in inactivation of hemolymph JH and thus in initiation of metamorphosis. In Galleria mellonella larvae hemolymph JHE activity increases on day 4 and remains high on days 5 and 6. Synthesis and/or release of hemolymph JHE in these larvae appears to be coupled with induction of a metamorphic molt. Larvae injured by removal of imaginal wing discs, during the early part of the last larval stadium pupate later than normal. In larvae that were injured on days 1 or 2 appearance of JHE hemolymph was also delayed. In larvae that were injured on day 4 there was a second peak of JHE on day 8 about a day before pupation. These observations suggest that presence of hemolymph JHE in these larvae is coupled with metamorphosis. If larvae were chilled on the day of ecdysis into the last larval stadium they usually undergo an extra larval molt. In the larvae that underwent a supernumerary molt no JHE activity was found. However if cold-induced supernumerary molt was inhibited by starving chilled larvae some of these larvae would pupate without an intervening supernumerary molt provided that they were fed for a certain number of hours after chilling. In such larvae JHE activity appeared in hemolymph by day 4, thus confirming the coupling of the stimulus for production of JHE and initiation of metamorphosis.

Larval abdomens ligated from 2-day-old larvae that were chilled on the day of their ecdysis into last instar do not produce any JHE unless specifically stimulated. These preparations were used to identify the source of the JHE inductive factor. Brain and subesophageal ganglion, but not fat body, from normal last instar larvae when transplanted into ligated chilled larval abdomens induced JHE activity. These data suggest that brain and possibly subesophageal ganglion may produce a JHE inducing factor.

5R-7,23 LARVAL-PUPAL TRANSFORMATION OF THE PROTHORACIC GLAND OF MAMESTRA BRASSICAE.

Hiruma, K. (Inst. Agr. Forest., The Univ. Tsukuba, Ibaraki, 305 Japan)

Change in responsibility of the prothoracic glands (PG) to juvenile hormone (JH) by secreting ecdysone was investigated using methods of experimental morphology. Stages of the PG activation by JH was restricted from 1 day before gut purge of the last (6th) larval instar to the pupal stage, while the activation by prothoracicotropic hormone (PTTH) could be recognized through the last larval instar and the pupal stage (Hiruma et al., 1978). In penultimate instar larvae, the PG were never activated by JH. Since allatectomy of the freshly ecdysed penultimate instar larvae induced precocious pupation, it was of interest to investigate the PG of the allatectomized larvae in the various developmental stages. In allatectomized animals, JH could activate the PG of the larvae 2 days before gut purge to those of the precocious pupae, but not activated the PG before the earlier than that stages. This change in PG sensitivity caused by allatectomy in the penultimate instar was similar to that of the PG in the last instar larvae. Therefore, it was concluded that in the PG of larvae destined for pupation there occurred a transformation from larval to pupal type as well as other organs did. JH I, JH II and ZR-515 (JHA) have a ability to activation of PG, but not JH III in the allatectomized larvae. While, PTTH activated the PG to secrete ecdysone of all stages examined.

5R-7,24 JUVENILE HORMONE CONTROL OF BROWN-BLACK PIGMENTATION OF LARVAL MARKING IN THE SILKWORM, BOMBYX MORI.

Kiguchi K.(Sericultural Experiment Station, Yatabe, Ibaraki 305, Japan)

In the silkworm, Bombyx mori, there are many mutants of larval marking which are essentially classified into three types in color; black, brown and their combination types. Brown pigmentation of the marking is induced experimentally by implantation of active corpora allata or injection of synthetic JH at an appropriate time, whereas black pigmentation is induced by extirpation of corpora allata(Kiguchi,1972, 1973). Such a color change offers a good experimental system to study not only action of JH but also mechanism of marking pigmentation. Autoradiographic studies indicated that ^{14}C-tyrosine was mainly incorporated into the cuticle of marking area when injected at the last stage of the larval molting period. However, incorporation of ^{14}C-tryptophan into the cuticle was very weak. ^{14}C-β-Alanine was incorporated into the brown part of the marking, but not into the black area. Injection of JH accelerated incorporation of ^{14}C-β-alanine into the marking cuticle, inducing brown pigmentation. On the other hand, allatectomy strongly inhibited incorporation of the amino acid, resulting black pigmentation. From these results, it is concluded that JH and β-alanine are involved in tyrosine metabolism during the larval molting period to form brown melanin.

5R-8,25

DIFFERENCES AND SIMILARITIES IN MODE AND MECHANISM OF ACTION BETWEEN DIFFERENT STRUCTURAL TYPES OF LEPIDOPTEROUS JUVENILE HORMONE ANTAGONISTS. Staal, G.B., Kramer, S.J., Bergot, B.J. (Zoecon Corp., Palo Alto, Calif., USA)

ETB (ethyl 4-[2-(tert-butylcarbonyloxy) butoxybenzoate]) can show antagonist and agonist (JH) activity, depending on the dose applied. However, this compound does affect the JH titer *in vivo* as well as the JH production of CA *in vitro*, which precludes an explanation through a negative feedback effect. Also, the JH production *in vitro* can be restored with farnesoic acid, indicating that ETB is rate-limiting at an earlier bio-synthetic step. Some other antagonists lacking the agonist component appear to act very similarly, but without the agonistic overdose effects that can be observed *in vivo* with ETB. The different types of antagonistic compound vary in their selectivity for lepidopterous species.

5R-8,26

INTRINSIC AND EXTERNAL REGULATION OF THE ALLATOTROPIC FUNCTION OF THE BRAIN. Hodkovà M., Hodek I. (Inst. Ent., Czechosl. Acad. Sci., 12800 Prague,Czechoslovaki)

The nature of regulation of CA switching activity of brain is different in adults and larvae of *Pyrrhocoris apterus* L. : while the adult brain depends on external signals, the larval brain appears to be rather self-governed.

Reproductive activity of adults is controlled by photoperiod: at 17L:7D active CA enables the females to mature and oviposit, under short day-length adult diapause is induced. According to environmental signals perceived, the brain stimulates or actively inhibits the function of CA. The base-line state of brain remains, however, the same.

Metamorphosis of Vth instar larva to adult is enabled by the discontinuation of CA activity between late IVth and late Vth instar. Although the brain is continuously exposed to feedback information from the body, the prerequisite for ceasing the CA stimulation is reaching the appropriate developmental stage of the brain and not a signal coming from outside. Independency of brain was demonstrated by opposite activity of brains taken along with active CA from early IIIrd or early IVth instar larvae, and implanted to early IVth instar larvae. Even within IVth instar larva the implanted IIIrd instar brain sustains the activity of its CA and causes a supernumerary ecdysis to VIth instar; in contrast, the implanted IVth instar brain discontinues activity of its CA.

5R-8,27

A STUDY OF MORPH DETERMINATION IN THE POTATO APHID USING PRECOCENE, A COMPOUND WITH ANTI-JUVENILE HORMONE ACTIVITY. Delisle, J. and C.F. Cloutier (Dept. Biology, Laval Univ., Québec,Canada, G1K 7P4)

We conducted experiments using precocene II in order to study the possible rôle of juvenile hormone (JH) in morph determination in the potato aphid, *Macrosiphum euphorbiae*. When kept on potato plants under long day conditions (18L:6D), all aphids in the colony are parthenogenetic viviparous females which may be alate or apterous depending mainly on population density. Newly molted apterae and aletae were treated with acetonic solutions of precocene ranging in concentration from 0.1 to 1 µg/individual. In both morphs the proportion of alatiform nymphs produced was significantly higher (increasing with concentration) than in controls for several days following treatment. However no reduction in fecundity was observed. These results suggest that high (JH) levels in the hemolymph of viviparae may be necessary for the production of apterous progeny. When reared since birth at photophases lower than 15 h, alatae and apterae normally produce mixed morph progeny including alate and apterous viviparae, males, and oviparous females. When newly molted apterae and alatae reared at 14L:10D were treated with precocene, the proportion of alatae produced was significantly increased, without any significant effect on the proportion of males, oviparous females, or both sexual morphs combined. Although further supporting a possible rôle of (JH) in promoting apterous development in non-sexual females, these results seem to indicate that it would not be involved in the photoperiodic response that normally results in return to sexual reproduction in the fall.

5R-8,28 THE EFFECT OF A JUVENILE HORMONE ANALOG ON THE VARIOUS DEVELOPMENTAL STAGES OF EPHESTIA CAUTELLA. Pisarev, V. and Shaaya, E. (Institute of Technology, Volcani Center, Bet Dagan, Israel.

The juvenile hormone analog, Altosid ZR 515, was found to interfere with the normal embryogenesis of Ephestia cautella in a manner dependent on dose and age. Young embryos prior to the stage of blastokinesis were found to be the most sensitive to the compound. Altosid prevented adult emergence when prepupae and young pupae within one day of pupariation came into contact with the compound. The pupal effect decreases with age.

Altosid causes the prolongation of larval life which is associated with the production of superlarvae at the age of 30 - 40 days. The superlarvae stop feeding and it seems likely that they enter diapause in the larval stage as long as they remain in contact with the compound.

The critical stages at which Altosid exerts its effect on the life cycle of Ephestia cautella will be discussed in relation to the changes in ecdysone titer.

5P,1 NEW APPROACH ON THE ROLE OF ECDYSONE IN LARVAL PUPAL DIFFERENTIATION. Shaaya, E. (Institute of Technology, Volcani Center, Bet Dagan, Israel.)

Analysis of the pattern of newly synthesized RNA in the epidermal cells of Calliphora during post embryonic development revealed that giant HnRNA is synthesized in the transition period from larva to pupa, but not in larvae of an earlier developmental stage. The appearance of this RNA species in this specific developmental stage is ecdysone dependent. This was shown by the removal of the ring gland (the source of the hormone) and by the injection of exogenous ecdysterone. Moreover, correlation between ecdysone titer and changes in RNA metabolism in the last larval instar show that the initial increase in HnRNA synthesis occurs shortly after the appearance of a small peak of ecdysone. It should be noted, however, that a second main peak of the hormone, which leads to pupariation, appears 2 days later. In situ, polysomes appear shortly after the main peak of ecdysone secretion and in young larvae deprived of the ring gland 3 hours after ecdysterone administration. These events are followed by new production of the enzyme, DOPA-decarboxylase, and pupariation. This observation suggests that after the second release of the hormone much more information is transferred to the cytoplasm. It is concluded that larval pupal differentiation involves initially gene activation dependent on the first release of ecdysone which leads finally to pupal cuticle synthesis and pupariation dependent on the second release of the hormone. Preliminary studies showed that the epidermal cells become committed to pupal differentiation after the first release of ecdysone.

5P,2 INACTIVATION AND REACTIVATION OF ECDYSONE DURING PUPAL-ADULT DEVELOPMENT OF THE FLESHFLY, SARCOPHAGA PEREGRINA. Moribayashi, A. and Ohtaki, T.(Dept.Techno.,N.I.H.,Tokyo,141 Japan

The inactivation process of ecdysteroids during pupal-adult development of the fleshfly, Sarcophaga peregrina, has been analysed, by chasing of injected ^{3}H-20-hydroxyecdysone. The 20-hydroxyecdysone was rapidly metabolized and converted mainly into three groups of metabolites, one of which is a substance closely related to 20-hydroxyecdysone in its chemical nature, and the other two are polar conjugates of 20-hydroxyecdysone (OA and OB). The percentage of the first group of metabolites decreased through the first day after the injection, but then reversed and began to increase after that day. those of conjugates OA and OB increased through the first day after and remained constant (OA) or began to decrease (OB). Conjugate OA introduced into pharate pupae changed to less polar substances, liberating 20-hydroxyecdysone at the begining of adult development.

5P,3 INTERSPECIFIC AND INTRASPECIFIC CHROMOSOMAL VARIATIONS IN LEPTINOTARSA BEETLES. Hsiao, T. and Hsiao, C. (Dept. Biol., Utah State Univ., Logan, Utah 84322, U.S.A.)

The genus Leptinotarsa (Chrysomelidae) contains about 45 species with the center of origin in southern Mexico. Most species feed exclusively on Solanaceae, while a few are specific on Compositae. Cytogenetic analyses were carried out on eight species--L. decemlineata, L. defecta, L. haldemani, L. juncta, L. libatrix, L. lineolata, L. texana, and L. tumamoca. All the species contain the same chromosome number of $2n = 34 + xo/xx$. Their spermatogonial karyotypes were mostly metacentric and submetacentric, but with no telocentric forms. Up to four acrocentric forms were observed in some species. Secondary constrictions were found in all the species. The identity of these karyotypes was verified by Giemsa stain. Intraspecific karyotype variations were investigated with various geographic populations of the Colorado potato beetle, an important agricultural pest. A single chromosomal variation was revealed. The North American and European beetles that feed on the potato have a pair of acrocentric chromosomes which was not present in an Arizona beetle population that feeds on Solanum elaeagnifolium. The equivalent chromosomes in the Arizona beetles were metacentric. Hybridization between the two types yielded viable progeny that possessed half of the chromosomal complements from each parent. The significance of the chromosomal variations in defining the biotypes of the Colorado potato beetle is discussed.

5P,4 MATURATION OF TICK SPERMATOZOA IN VITRO. Shepherd, J. and Levine, S. (Biology Dept., State Univ. of New York, Binghamton, NY 13901, USA)

The sperm cells of ticks (Acarina, Ixodoidea) undergo complex morphogenetic changes after their transfer to the female during mating. These changes have been followed by time-lapse cinematography of Ornithodorus sperm in vitro -- these films reveal several new phenomena, including evidence that the prime motive force for the morphogenesis probably arises from contractions occurring in the outer sheath of the sperm. The nature of the factor(s) inducing morphogenesis has also been investigated using sperm cells dissected from the male and maintained in vitro. The morphogenesis can be induced by extracts of the accessory glands of the male reproductive tract and requires no contribution from the female. The factor obtained from the accessory glands is a polypeptide with a molecular weight of about 12,000 daltons. The main action of the factor on the sperm appears to be the opening of a membranous cap ("operculum") on the anterior end of the sperm which allows the morphogenesis to proceed normally. In the absence of the factor in vitro, the cap does not open but contractions eventually begin and cause an abnormal morphogenesis.

5P,5 ECDYSTEROIDS IN OVARY AND EMBRYO OF THE SILKWORM, *BOMBYX MORI*

Ohnishi, E., Mizuno, T., Watanabe, K., (Biol. Inst., Facult. Sci., Nagoya Univ.), Ikekawa, N., Ikeda, T. (Lab. Chem. Natural Prod.)

In the silkworm, *Bombyx mori*, ecdysteroids are synthesized in ovary during the pupal and pharate adult stages. In ovary, four species of ecdysteroids are accumulated in free and conjugated forms. After oviposition, these ecdysteroids are partly transformed into another forms and disappear at the hatching of larva. These changes will be discussed in relation to oogenesis, embryogenesis and possible metabolic pathways.

5P,6 CHARACTERIZATION OF GENETIC VARIABILITY IN DIFFERENT MULTIVOLTINE BREEDS OF SILKWORM, *B. mori* THROUGH GEL ELECTROPHORESIS.

Datta, R.K., Chatterjee, S.N., and Pramanik, H.

Genetic variability existing in indigenous and different improved breeds (multivoltine) of *Bombyx mori* L. was unveiled by polyacrylamide gel electrophoresis of haemolymph proteins and isozymes. The haemolymph of male and female larvae and pupae at different developmental stadia was collected and centrfuged at 10,000 g and the supernatant was loaded on 5% polyacrylamide gel. Data revealed that maximum number of protein bands appear just before the spinning stage whereas many bands disappear during pupal morphogenesis. Of interest is to note that a few differentiating bands are seen inimproved breeds, CB2 CB5 during spinning stage compared to those in the indigenous race "Nistari" though most other protein bands are similar in all the breeds. This indicated the divergence and fixation of new gene pool during breeding. Isoenzyme pattern studied eletrophoretically also confirmed that new hybrid band occured when the improved breeds were crossed among themselves.

5P,8 GENETICS OF INSECT HAEMOLYMPH β-N-ACETYLGLUCOSAMINIDASE IN THE SILKWORM, *BOMBYX MORI*

Kimura, S. (Div. Physiol., Sericul. Exptl. Sta., 305 Japan)

The distribution of insect haemolymph β-N-acetylglucosaminidase was investigated in the silkworm, *Bombyx mori*. Activity in one hundred fifteen varieties was 6.92 ± 3.22 units/ml, ranging from 1.4 to 17 units/ml. No enzyme-deficient individuals were observed. By selecting individuals showing either high or low enzyme activities, homozygotes were separated with activities varying ten-fold between isolates. Studies on the heredity of the enzyme indicated that the synthesis of the enzyme protein was controlled by an autosomal allele. Examination by immunotitration and column chromatography revealed that the difference in activity between High and Low lines was due to the amount of the active enzyme, but not to an endogeneous activator or inhibitor. Furthermore, there was no isozymic difference in β-N-acetylglucosaminidase. Slab gel electrophoresis on polyacrylamide showed a species of enzyme (A) that stained more intensitively in the High line. For the second species of enzyme (B) the converse was true. This evidences suggest that enzyme levels in haemolymph are under the control of a gene affording association of enzyme subunits to the active enzyme molecule.

5P,9 ESTABLISHMENT OF A CELL LINE FROM EMBRYONIC TISSUES OF THE FLESHFLY, *Sarcophaga peregrina* (INSECTA: DIPTERA).

Takahashi, M., Mitsuhashi, J. and Ohtaki, T. (Dept. of Ent., Nat. Inst. Health, Tokyo, Tokyo 141 Japan)

A continuous cell line was established from the embryonic tissues of the fleshfly, *Sarcophaga peregrina*, and was designated as NIH-SaPe-1. The primary culture was initiated in October, 1977, and the cell line was passed 68 times during the following year. The cells were heterogeneous in morphology. Most cells were diploid and their chromosomes consisted of 4 metacentric, 6 subtelocentric and 2 micro chromosomes. The population doubling time of the cell line was about 30 hours. The cells grew faster in Mitsuhashi and Maramorosch medium than in Schneider medium. The cells could be stored in the usual medium at 5°C for about 3 months or in the medium containing 10% glycelol at -80°C for a longer period. The cell growth was suppressed by 20-hydroxyecdysone more concentrated than 0.01 μg per ml, whereas insulin did not show any effect on the cell growth at the strength of 0.4 and 0.04 IU per ml.

5P,10 CONTRIBUTION OF IN VITRO EXPERIMENTATION TO THE STUDY OF INSECT SPERMATOGENESIS.

Leloup A.M. (Unité de Morphologie Animale, U.C.L. 1348-LOUVAIN-LA-NEUVE, BELGIUM)

A glance at the progress made these last ten years will enable us to stress in which way the in vitro techniques of organ culture have proved to be a unique tool to investigate factors involved in the control of Insect spermatogenesis, and to remind working hypotheses formulated last year (LELOUP & al., in press). Experiments are in progress in an attempt to discriminate between them and some results dealing with the action of alpha- and beta-ecdyson will be reported.

5P,11 THE FIELD CENTRE IN THE POLAR COORDINATE MODEL FOR EPIMORPHIC REGULATION.

Sibatani, A. (CSIRO Molecular and Cellular Biology Unit, Sydney: North Ryde, N.S.W. 2113, Australia)

The polar coordinate model (French et al., 1976) included the shortest intercalation rule and the complete circle rule to explain pattern regulations in insect and amphibian legs and imaginal discs of Drosophila. Subsequently the complete circle rule was experimentally refuted. In an alternative model, Strub (1979) distinguished two regulative modes for intrasegmental and global fields in insect legs. I wish to argue that the logical implications of the original model deserve further exploration.

The polar coordinate model should be conceived as a circular part of a "derived" 2-D space (R), which is spanned by two field value components (angular and radial), and onto which the morphogenetic field in actual space (S) can be mapped. The circle centre in R is a singularity occurring on or off the prospective distal end in S. I will call this singular point in S the field centre. Let us assume that the angular component at a given level of the radial component ($\neq 0$) encompasses more than 3 distinctive values over a circumference. Removal at this radial level of an area containing the field centre will generate, upon wound healing, a discontinuity in the angular component in R because of the apposition of cells having disparate angular values. But at the original circle centre there should be no such discontinuity. Hence, the central discontinuity, once generated, can be abolished only through terminal regeneration producing a new field centre. A complete circle is not necessarily required for emergence of a central discontinuity. Either a mirror-image duplication or a transplantation of distal fragments will alleviate the central discontinuity and hence suppress terminal regeneration. Moreover, a centripetal degeneracy down to only 3 distinctive angular values can replace the shortest intercalation rule. This refinement of the polar coordinate model makes the alleged refutations inadequate.

5P,12 THE USE OF TANNIC ACID TO STUDY BASEMENT MEMBRANE SECRETION DURING TISSUE DIFFERENTIATION

Lai-Fook, J. (Dept. Zool. Univ. Toronto, Toronto, Ontario M5S 1A1 Canada

Fixation in 5% tannic acid and 2.5% glutaraldehyde in cacodylate buffer, and postfixation in osmium tetroxide, gives rise to differential contrast in differentiating tissues secreting basement membrane, as observed with light and electron microscopy. The adult male genital tract of *Calpodes ethlius* develops in the pupa from tissue present only as two thin strands in the larva. It consists of highly variable epithelia separated from one or more muscle layers by a thick basement membrane. Fixation in tannic acid during secretion of this membrane appears to influence epithelial contrast. Initially, before basement membrane secretion, the contrast of the presumptive tract tissue is uniformly high, however, as basement membrane is secreted, the contrast of the epithelia becomes uneven as those cells overlying basement membrane lose their contrast, while those without an underlying basement membrane retain their high contrast. Eventually the basement membrane becomes continuous between the epithelia and muscle layers, then the epithelia exhibit uniform low contrast. The technique is being applied to the problem of the origin of the epithelia.

5P,13 CYTOGENETICAL STUDIES IN THREE SPECIES OF GENUS *APHIS* (HOMOPTERA : APHIDIDAE). *Misra*, S.D. and Kurl, S.P. (Dept. Zool., Jodhpur Univ., Jodhpur, 342001 India)

The diploid chromosome numbers of the species, viz., *Aphis craccivora* (Koch), *A. gossypii* Glover and *A. nerii* Boyer was found to be 8, collected from a large number of field populations from different localities on different host plants. However, in one population of *A. craccivora*, collected from host plant, *Acacia arabica*, the chromosome number was found to be 2n=7. The preparations were made by air-drying technique, using Giemsa stain. In a detailed mitotic cell division the homologous pairs from early metaphase stage were selected, the karyotypes were constructed and the metrical measurements given. In all the cases the chromosomes were found to be holocentric. The mean percentage lengths vary in *A. caccivora* (2n=7) 20.31 to 8.50; *A. craccivora* (2n=8) 16.14 to 3.24; *A. gossypii* (2n=8) 15.39 to 8.83 and *A. nerii* (2n=8) 19.59 to 7.34. Their cytotaxonomy has also been discussed.

5P,14 DEGENERATION AND ENCAPSULATION OF ALCOHOL-HYPERSENSITIVE SILKGLAND CELLS IN *BOMBYX* LARVAE. AKAI, H. (Sericult. Exp. Stat., Ibaraki 305, Japan)

In *Bombyx* larvae, an inscrutable phenomenon that the specific regions of the silkgland degenerate abnormally by the inhalation of alcohol vapour is observed. The processes of ultrastructural changes of the cells and the encapsulation by hemocytes were studied in relation of the larval molting cycle. After the contact with the alcohol vapour, the ultrastructural changes, such as, chromatin condensation, degeneration of mitochondria, increase of lipid droplets, and etc., occur in the cells. Encapsulated tissues are formed on the outer surface of the degenerating regions by plasmatocytes and granulocytes. The plasmatocytes make a inner layer at first, and then, the granulocytes participate in the action.

5P,15 MALE EGG VIABILITY IN A STRAIN OF MEGOURA VICIAE (HOM.APHID.). Crema,R.,(Inst.Zool. Modena Univ.,41100 Modena,Italy)

In a strain of *Megoura viciae* Buckt. abortive eggs were found only when environmental conditions favoured the appearance of males.By means of different rearing environments various experimental categories of parthenogenetic females were obtained.In each of them male sex determination took place in a different position within the ovariole.The position in which the abortive eggs appeared always coincided with that in which the eggs were determined as males.To elucidate this phenomenon the ovariole position involved was examined quantitatively regarding the numbers of males,females and abortive eggs. χ^2 analysis of the data shows that the null hypotheses that viable male eggs are equal in number to abortive male eggs cannot be disproved.Very likely the inviability of the male egg is caused by the presence of recessive lethal(s) on the X chromosome.

5P,16

CHORION SCULPTURES AND AMINO ACID COMPOSITION OF ORTHOPTERAN EGGS. Mazzini, M. (Institute of Zoology, University of Siena, Italy)

The chorion (eggshell) of several species of Orthoptera (Gryllidae, Phaneropteridae, Meconemidae, Conocephalidae, Tettigoniidae, Sagidae and Acrididae) has been studied by scanning electron microscopy (SEM) and amino acid analysis.
SEM investigations show species-specific structure even within the same genus. The structures of the external surface, of the external and internal chorion layers, of the respiratory system and of the micropylar orifices represent taxonomic characters useful for the exact classification of the eggs.
The chemical data suggest that protein is the major component of the chorion (Furneaux and MacKay, 1972). Particularly interesting is the aminoacid composition of Tettigonioidea (Phaneropteridae Meconemidae, Conocephalidae, Tettigoniidae and Sagidae) egg shells which are characterized by a large amount of glycine (from 30% to 48%) and rather considerable quantities of leucine and valine, but only traces of cystine and methionine. In Gryllidae serine is the most abundant egg amino acid residue (about 40%), followed by glutamic acid, isoleucine and aspartic acid; cystine is present in considerable amounts. On the other hand eggshells of Acrididae, differing markedly from the other families, do not have any sharply predominant amino acid.

5P,17

Hormonal regulation of hemoglobins during Chironomus development. Laufer, H. and Vafopoulou-Mandalos, X., University of Connecticut, Storrs, U.S.A.

The ontogeny of Chironomus thummi hemoglobins (Hbs) was investigated during the 3rd and 4th instars and at metamorphosis as were the effects of juvenile hormone (JH) and ecdysterone on Hb synthesis. The hemolymph of Chironomus larvae consists mainly of polymorphic, monomeric Hbs, as revealed by acrylamide gel electrophoresis. Two Hbs (2 & 3) are stage-specific and are first synthesized *in vitro* by day-4 of the 4th instar as assayed by isotope incorporation. Hb concentration fluctuates with development. It is high in intermolt animals (80% of total hemolymph protein in mid-4th instars) and low in intermolt animals. Hbs are degraded in pupae. *In vitro* Hb synthesis by the fat body also fluctuates during development. Hb synthesis seems to decrease at the time ecdysterone is secreted to induce molting. Indeed, *in vitro* ecdysterone treatment of fat body cultures from mid-3rd-and mid-4th instars strongly inhibits total Hb synthesis. Application of JH to newly molted 4th instars prolongs the 4th instar, induces the formation of larval-pupal intermediates and increases Hb content. Most significantly, it induces the precocious synthesis of Hbs 2 and 3 at day-2 of the 4th instar. Also, *in vitro* administration of JH stimulates the fat body to precociously synthesize these two Hbs. Actinomycin D *in vitro* inhibits the early synthesis of Hbs 2 and 3 and effectively suppresses the other Hbs. It also inhibits puffing of salivary gland polytene chromosomes and total RNA synthesis in the fat body. On the contrary, it does not affect total Hb synthesis in intermolt animals (mid-4th instars) for up to 30 hours. Combined treatments of ecdysterone and actinomycin D completely suppresses Hb synthesis in mid-4th instar fat bodies. It is suggested that, while Chironomus normally possesses stable Hb messenger RNAs, molting as induced by ecdysterone, is related to Hb message depletion. Recovery of Hb synthesis then depends on stimulation of Hb genes by JH to synthesize new functional RNA species.
(Supported in part by grants from NSF and Univ. of Conn. Research Foundation).

5P,18

OCCURRENCE OF FLIGHT MUSCLE RUDIMENTS IN TWO LEPIDOPTEROUS LARVAE, *PIERIS RAPAE CRUCIVORA* AND *BOMBYX MORI*. H. Tsujimura, (Lab. Biol., Tokyo Univ. Agri. Tech., Fuchu, Tokyo, 183, Japan)

In holometaborous insects, most of the imaginal muscles differentiate from myoblasts in the pupal stage. But the origin of myoblasts haven't yet been clarified and the question whether rudiments of the adult muscles occur in the larva is still open. In this study I followed up the development of the flight muscles by micro dissection in two lepidopterous insects, and confirmed the occurrence of rudiments of the indirect flight muscles in the 4th and 5th larva. The main dorsal longitudinal muscles differentiate from two rudiments and the dorso-ventral muscles from three. Three of them are composed of myoblasts occurring on the substratum of larval muscles and along the innervating motor nerve. The other two are thin fibrous tissues with many myoblasts aggregating at a part of the tissues. All of these rudiments are in contact with the peripheral nerve.

5P,19 NEUROENDOCRINE REGULATION OF SEASONAL FORM DEVELOPMENT IN SEVERAL SPECIES OF BUTTERFLIES.

Endo, K.(Dept.Biol.,Yamaguchi Univ., Yamaguchi, 753 Japan)

The development of seasoanl forms was studied in several species of butterflies, namely Polygonia c-aureum,Arashnia burejana,Papilio xuthus.
In the case of P.c-aureum, the development of seasonal forms which is connected with the adult reproductive diapause seems to be determined by day-length and temperature conditions throughout neuroendocrine secretion from medial neurosecretorycells of pars intercerebralis-corpus cardiacum-corpus allatum system. The medial neurosecretory cells which are connected with the development of seasonal forms seems to be limited in number less than 8 large cells.
In the cases of A.burejana and P.xuthus, the development of seasonal forms which is connected with the pupal diapause may be determined in diapause pupae 5 or 6 days after pupation.

5P,20 PURIFICATION AND PROPERTIES OF THE BRAIN HORMONE OF THE SILKWORM, *BOMBYX MORI*.

Funatsu, M., Aizono, Y., Matsuo, N., Funatsu, G. and Kobayashi, M. (Dept. Appl. Microbial Technol., The Kumamoto Institute of Technology, Kumamoto, 860 Japan)

The brain hormone, *i.e.*, Prothoracicotropic Hormone, capable of affecting the prothoracic glands was purified from the heads of *Bombyx* moths for elucidating the nature of the hormone. The hormone extracted from acetone powder with 2% NaCl at pH 6.8 was partially purified by heat-treatment(85°C, 5 min), followed successively by ammonium sulfate precipitation(0.3 - 0.7 sat.), acetone fractionation(20 - 65%) and picric acid precipitation(0.5 sat.). Further purification of the hormone was carried out by successive column chromatography on DEAE-cellulose(0.1 M ammoniumbicarbonate, pH 8.3), CM-Sephadex C-50(20 mM acetate buffer, pH 5.0) and hydroxylapatite(10 mM phosphate buffer, pH 6.5), and gel-filtration through Bio-Gel P-60(6 M urea, pH 4.3). In final, the isolation of the hormone was accomplished by means of preparative polyacrylamide gel disc electrophoresis(6% gel; 6 M urea, pH4.3). The sequence of purification steps effected a 1,700-fold increase in specific activity with a 4.1% yield. The hormone activity was assayed by using male Dauer-pupae of *Bombyx mori* as test objects. From 3.56 Kg of acetone powder prepared from 1.5×10^6 heads of moths, 5.3 mg of the hormone with a specific activity of 100,000 units per mg of protein was separated through ten steps. The hormone purified and then iodinated with ^{125}I was homogeneous and its molecular weight was evaluated to be 18,000 by SDS-polyacrylamide gel electrophresis. The hormone was shown to be stable in both 6 M urea and 6 N guanidine hydrochloride solution without losing any activity. The treatment of the hormone with the protease of *Str. griseus* caused inactivation of the hormone. When the hormone was hydrolyzed with 6 N HCl, several amino acids were detected in the hydrolyzate by dansyl chloride procedure, indicating that the hormone comprised amino acids. The evidence demonstrated that the purified hormone was a protein being stable to protein denaturants.

5P,21 IS CORPUS ALLATUM MORPHOGENESIS A CHARACTER OF OVIPARA NEOTENY IN APHIDS?

Bonvicini Pagliai, A.M.,(Inst.Zool.,Modena Univ.,41100 Modena,Italy)

The aphid oviparae are generally considered as more extreme neotenic than apterous virginoparae because of their larger number of larval features.
In Megoura viciae(Bonvicini Pagliai,Ann.Soc.Ent.Fr.,9:729-734,1973;Bonvicini Pagliai & Crema,Boll. Zool,42:197-200,1975) the ovipara corpus allatum develops as paired rudiments,which fuse into a single median body only during postembryonic development.A similar morphogenetic pattern has been detected in oviparae belonging to other species of aphids.It seems,therefore,that the delay in corpus allatum fusion may be a common feature in aphid oviparae.Such morphogenetic behaviour is to be considered as a further neotenic character.

Section 6.

Pathology.

6S-1,1 USE OF FUNGI FOR THE CONTROL OF INSECT PESTS

Aoki, J. (Facult. Agr., Tokyo Univ. Agr. Tech., Tokyo, 183 Japan)

Using scanning electron microscopy, the persistency and infectivity of *Beauveria tenella* in soil were investigated in order to clarify the potential for microbial control of the scarabaeid larvae. The hyphae became thin and disappeared. The conidia continued to exist in soil and germinated on *Anomala costata* larvae. The germ tubes grew over the cuticle, and penetrated into the hemocoel. The fungus was tested for conidial formation under various culture conditions. The highest amount of conidia was produced in the light with wheat bran as cultural substance. The conidial formation was greater with hyphal bodies inoculum than with conidia inoculum in a short period of time. The resting spores of *Entomophthora virulenta* and *E. thaxteriana* germinated *in vitro* in the light. Ultrastructual observations indicated that the endospore layer of the spores of *E. virulenta* was disintegrated possibly by enzymatic actions.

6S-1,2 Molecular Biological Studies Relating to the Entomopathogenicity of *Beauveria bassiana*.

Grula, E.A., (Dept. Cell, Molecular and Developmental Biology, Ok. St. Univ. Stillwater, OK.)

Our basic mission is to determine why the fungus *Beauveria bassiana* is a mycoinsecticide; then use the knowledge gained to develop and isolate mutants having very high pathogenicity. Mutant strains having high and low pathogenicity have been isolated and several of their characteristics are being studied and compared. These include: (1) Ability to penetrate the integument of *Heleothis zea* and other insect pests; (2) Invasive enzymes secreted soon after germination of fungal conidia and during subsequent growth of the hyphae; (3) Nutrients required for germination of conidia (including those that might be present on the surface of insect larvae); (4) Compounds on the surface of larvae that could be toxic to germination and/or growth of the fungus; (5) Modification of larval haemolymph components (proteins, amino acids, carbohydrates) by injected mutant strains of *B. bassiana* having high, low or negative proteolytic ability. All of these parameters will be discussed and an attempt made to present a unified mechanistic hypothesis relating to entomopathogenicity of *B. bassiana*.

6S-1,3 GENETIC FACTORS FOR IMPROVING ENTOMOPATHOGENIC BACTERIA: CURRENT RESEARCH.

Faust, R. (Insect Pathol. Lab., ARC, USDA, Beltsville, Md. 20705 USA)

Entomopathogenic bacteria may offer a relatively safe system for studying DNA transformation and recombinant DNA research for genetically manipulating these bacteria. Envisaged in this research are possible applications to (1) expand the spectrum of insect hosts of existing pathogens, (2) develop new, more potent strains, (3) improve the physiological tolerance of these bacteria, and (4) facilitate the *in vitro* commercial production of the more fastidious pathogens by expanding the range of substrates upon which they can be grown.

The use of plasmid or bacteriophage vectors is a primary consideration. Plasmid DNA's (1.0- 50 X 10^6 daltons) have been described in most serotypes of *Bacillus thuringiensis* and in *B. popilliae* with some evidence that they may be involved in the synthesis of toxic parasporal crystals. A number of bacteriophages have also been reported; one transducing phage for *B. thuringiensis* (TP-13) converts oligosporogenic, acrystalliferous mutants to spore positive, crystal positive at a high frequency. In our studies we are attempting the splicing of antibiotic resistance genes into plasmids of *B. thuringiensis* to render them more useful in transformation studies, and the introduction of plasmids from other species such as the *Staphlococcus aureus* pUB 110 (neo/kan).

We recently examined serotypes of *B. thuringiensis* and *B. popilliae* for inherent antibiotic resistance and mutation potential to neomycin and kanomycin. Three serotypes developed no resistant mutants to either antibiotic in populations as high as 3.0 X 10^{10}, seven other serotypes developed no resitance to kanamycin in populations as high as 4-6 X 10^9 cells. Three other serotypes exhibited mutation rates as high as 1.6 X 10^{-2} to both antibiotics. *B. popilliae* was susceptible to both neomycin and kanomycin. We now have presumptive evidence that one strain of *B. thuringiensis* is transformable with the pUB 110 plasmid. We are presently attempting to confirm these findings.

6S-1,4 CHARACTERIZATION OF THE ENTOMOCIDAL PARASPORAL CRYSTAL OF *BACILLUS THURINGIENSIS*.

Bulla, L. A., Jr. (SEA, USDA, and Div. Biol., Kansas State Univ., Manhattan, KS, USA).

The parasporal crystal of *Bacillus thuringiensis* is a glycoprotein composed of a repeating subunit whose molecular weight is approximately 1.3 x 10^5. The subunit is a protoxin that can be dissociated virtually in native conformation by mild alkaline titration. Reaggregation occurs slowly especially at pH $\leq$ 12 or the subunit also may antolyze to smaller fragments. The protoxic subunit can be purified by anion-exchange chromatography and a toxin can be generated by incubation of solubilized protoxin at pH 8.4 and purified by gel filtration and anion-exchange chromatography. The toxin is a glycoprotein with an apparent molecular weight of 68,000. The biochemical and biophysical properties of protoxin and toxin will be described.

6S-1,5 UTILIZATION AND MASS PRODUCTION OF *SPODOPTERA LITURA* NUCLEAR POLYHEDROSIS VIRUS FOR CONTROL OF THE TOBACCO CUTWORM, *SPODOPTERA LITURA* F.

Okada, M. (Chugoku Nat. Agr. Exp. Sta., Fukuyama, 721 Japan)

In the microbial control of the tobacco cutworm, *Spodoptera litura* larvae, *S. litura* nuclear polyhedrosis virus(SlNPV) was most effective. Control of the tobacco cutworm was possible by the application of 1X10^{11}(PIBs)/10a(13 larval equivalents). In the comparative control tests among ordinary, mist and ultra low volume spray of SlNPV to the tobacco cutworm, ultra low volume spray(ULV) caused the highest larval infection with SlNPV. ULV spray method was also more effective for the persistence of the virus than other spray methods. An artificial diet for rearing the tobacco cutworm was developed and mass successive rearing techniques on the artificial diet were established. Mass propagation and formulation techniques of SlNPV and bioassay techniques of potency of SlNPV preparation were studied successfully. Pathogenicity to silkworm and toxicity to white mice of SlNPV preparation were not detected.

6S-1,6 USE OF VIRUSES FOR THE CONTROL OF THE FOREST PEST INSECTS

Katagiri, K. (For. For. Prod. Res. Inst., Ibaraki 305, Japan)

Most economical method for mass propagation of CPV of *Dendrolimus spectabilis* was to rear mature larvae on pine branches sprayed with CPV (10^6 polyhedra/ml) and covered with cloth bags. The larva yielded about 10^9 polyhedra in 2 or 3 weeks. These larvae were macerated with water, filtered with cheese cloth. Resulting suspension was mixed with silica powder and added some other wettable agents to formulate as the insecticide. This CPV-insecticide controlled the pine caterpillar effectively.

D. superans, *Lymantria dispar*, *L. fumida*, and *Hyphantria cunea* were also controlled with their own viruses.

6S-2,8 INFECTION PROCESSES OF FUNGI.

Roberts, Donald W. (Insect Pathology Resource Center, Boyce Thompson Institute, Tower Road, Cornell University, Ithaca, New York 14853 USA.)

The infective unit of entomopathogenic fungi usually is either a motile zoospore (aquatic phycomycetes) or a conidium (entomophthorales and higher fungi), with a few cases of ascospores. Conidia are the most commonly encountered infective unit. The infection process can be divided into stages: 1. Attachment to the insect cuticle. Both chemical and electrostatic forces may be involved. Interactions between lipophylic compounds on the spore surface and lipids on the host cuticle probably are the most important. 2. Germination. In general, spores of entomopathogenic fungi are dormant in microbiological rich environments, such as soil, even though humidity and temperature are appropriate for germination. They germinate rapidly, however, after attachment to insect cuticles. The factors responsible may be chemical stimulation by compounds on the insect cuticle, physical stimulation associated with the attachment process, or physical isolation from competing microorganisms which may effectively utilize other substrates but not cuticles of living insects or which may be producing fungistatic compounds. 3. Penetration of cuticle. This may be accomplished by direct penetration by germ tubes or by infection pegs from appressoria produced at the end of short germ tubes. Both chemical and physical forces are involved, but the chemical (enzyme) action is the more important. Since the cuticle is a complex of lipids, proteins, and carbohydrates (particularly chitin), a variety of enzymes are presumed necessary for penetration. 4. Growth in the hemocoel. If the fungus successfully penetrates the cuticle and proliferates in the hemocoel (usually as "hyphal bodies" or blastospores), the insect will not survive. Toxins are produced in the hemocoel by many fungi. These compounds initially probably weaken defense reactions of the host and eventually cause its death. Although very important to the understanding of how fungi may be combatted in the case of beneficial insects or utilized for pest control in the case of pest insects, the details of the infection processes of fungi are only partially understood.

6S-2,9 NATURE OF INFECTIOUS PROCESSES OF *BACILLUS THURINGIENSIS*.

Faust, R. (Insect Pathol. Lab. ARC, USDA, Beltsville, Md. 20705 USA)

At least three metabolites with adverse effects on insects and a few other substances, including spores are produced by *B. thuringiensis*: (1) the toxic parasporal crystal (*B.t.* δ-endotoxin); (2) the thermostable fly toxin (*B.t.* β-exotoxin); (3) Phospholipase C (*B.t.* α-exotoxin); (4) an enzyme(s) (*B.t.* γ-exotoxin); (5) a "labile exotoxin" that is toxic to larvae of Tenthredinidae; (6) a "water-soluble toxin" that evokes symptoms in larvae similar to the crystal toxin; (7) a "mouse factor exotoxin" that causes a reduction of growth in lepidopterous larvae; and (8) proteinase(s) of unknown importance. These substances, in part, are responsible for pathogenicity to insects in the orders Lepidoptera, Diptera, and Coleoptera. The first three metabolites have been intensively studied in relation to their involvement in the infectious process.

The *B.t.* δ-endotoxin effects disruption of the microvilli, endoplasmic reticulum, mitochondria, and separation of cell wall membranes. Biochemically, this toxin causes uncoupling of oxidative phosphorylation in cells, stimulation of glucose uptake, and breakdown of permeability control. Recent evidence indicates that toxin affects the cell cytochrome system resulting in reduction of the oxidized form, and conformational change. Toxic subunits have proton-carrying properties promoting electrogenic H^+ transport across mitochondrial membranes. The *B.t.* β-exotoxin prevents pupae from developing into complete adults and acts whenever mitosis occurs during metamorphosis. The *B.t.* α-exotoxin acts upon cell membranes and affects the phospholipid causing necrotizing action. Its role in the invasion and pathogenicity is not well understood. Pathogenicity of *B. thuringiensis* has also been attributed to the last four toxins, chitinases, and possibly a thuringiolysin.

6S-2,10 INFECTIOUS PROCESS OF A CYTOPLASMIC-POLYHEDROSIS VIRUS IN THE SILKWORM, *BOMBYX MORI*.

Watanabe, H. and Kobayashi, M. (Fac. Agr., Univ. of Tokyo, Tokyo, 113 Japan)

Infectious process of a double-stranded RNA virus, a cytoplasmic-polyhedrosis virus, in the midgut epithelium of the silkworm, *Bombyx mori*, was studied by means of electron microscopy and radioautography. After ingestion of polyhedra, they were dissolved by the gut juice in the lumen and some of the liberated virions attached to the surface of microvilli of the columnar cell, releasing the core substance into the cytoplasm. The progeny-virus RNA seemed to be synthesized in the nucleus passed out into the cytoplasm and moved to an apical region where the virogenic stroma was formed. The virogenic stroma was proteinaceous and consisted of very fine filaments and granules. A degradation of the rough-ER took place around the virogenic stroma, indicating some correlation with viral protein synthesis. The assembly of virions occurred on the surface of virogenic stroma : the core-like dense material diffused among free ribosomes around the virogenic stroma was enclosed by protein granules from the virogenic stroma. When mature virions increased to a considerable amount, the formation of polyhedra started on the surface of the virogenic stroma. Many threads of polyhedral protein diffused into a relatively large mass of virions and formed a minute polyhedron. After crystallization of the protein, the polyhedron continued to increase in size occluding many virions in a random manner, while uniformly retaining its outline. At an advanced stage of cytoplasmic polyhedrosis, great masses of virogenic stroma and numerous polyhedra occupied the greater part of the cytoplasm, resulted in cell lysis and effluence of polyhedra, free virions, and cell organelles into the lumen. The destruction of infected cells induced the differentiation of new columnar cells from regenerative cells, however, the newly differentiated cells were also susceptible to the virus.

6S-2,11

INFECTIOUS PROCESSES OF BACULOVIRUSES IN INSECTS. Tanada, Y.(Dept. Ent. Sci., University of California, Berkeley, CA 94720, USA)

The insect baculoviruses, nuclear polyhedrosis (NPV) and granulosis (GV) viruses, are enveloped DNA viruses which are occluded in proteinaceous crystalline occlusion bodies. They invade the insect's midgut by fusion of the viral envelope to the cell membrane, and rarely by intercellular penetration. The phospholipid component of the envelope is essential for fusion. A synergistic factor in the capsule protein of a GV enhances the fusion. The nucleocapsid migrates to the nuclear pore. In the case of GV, the nucleic acid is inserted into the nucleoplasm, while in NPV the entire nucleocapsid passes through the nuclear pore. In the nucleoplasm, there is an eclipse period and then a virogenic stroma develops which produces nucleocapsids. Some nucleocapsids become enveloped and are occluded in occlusion bodies, other unenveloped and enveloped virions migrate out of the cell and may acquire an envelope from the plasma membrane. The nonoccluded virions infect tissues in the insect hemocoel by pinocytosis. The infection of some baculoviruses is tissue specific. Those which infect vital tissues cause rapid death; others produce prolonged infections. Infection of the hypodermis results in the typical wilt syndrome.

6S-2,12

BIOLOGY AND INFECTIVITY OF BACILLUS POPILLIAE. Bulla, L. A., Jr. (SEA, USDA, and Div. of Biol., Kansas State Univ., Manhattan, KS, USA).

Bacillus popilliae represents a unique category among bacteria. It is gram-variable, facultatively anaerobic, catalaseless, and insecticidal for various scarabaeid beetles. The bacterium, when ingested by beetle larvae, invades the hemocoel wherein it undergoes vegetative proliferation and subsequent sporulation causing death of the larvae. During the sporulation cycle, a parasporal crystal is formed within the bacterial cell that appears to be toxic. The crystal is a glycoprotein that is soluble under alkaline conditions. Solubilized crystal preparations are insecticidal when injected directly into the hemolymph. Partial characterization of the parasporal crystal will be described as well as its possible junction in the overall infectious process.

6S-2,13

MICROSPORIDIOUS INFECTION IN INSECTS WITH PARTICULAR REFERENCE TO INFECTION OF BOMBYX MORI WITH NOSEMA BOMBYCIS. Ishihara, Ren(Dept. of Agri.,Nihon Univ. Setagaya-ku,Tokyo 154, Japan)

Spores, when swallowed by larvae, discharge their polar filaments(PFs) through which infectious agents, sporoplasms(SPs) are injected into host gut cells. The nature of stimuli responsible for PF discharge is to be briefly reviewed. Although this way of invasion was demonstrated beyond any doubt, this does not necessarily mean that it is the only way of invasion. PF may penetrate the gut epithelium to send SP directly into hemocoel, if the spore is in close proximity to the gut cell. Histological observations suggest that SP, when discharged between gut epithelium and peritrophic membrane stands against the digestion by gut juice and invade gut cell. Minimum infectious dose is less than 10 spores per second instar larvae in contrast to the multiplicity of infection of culture cell with Nosema bombycis(Nb) being more than 10. After invasion, Nb grows to form primary focus in gut cell. It can also grow in any type of culture cell tested so far, so that the requirements for growth are not meticulus. During its development, infectious form is produced and subsequently released into hemolymph to transfer Nb over other tissues. Infectious form free from host cells can experimentally infect Bombyx mori and culture cells as well. Newly formed spores seem not to discharge their PFs spontaneously inside host and to be less sensitive to stimulants in vitro for some length of period after their harvest from infected hosts. Therefore, spores are not responsible for endogenous infection and the reinfection by those spores dropped into the lumen with host cell debris, if any, can not be intensive, leaving those spores expelled with feces of the host for further infection of other larvae. Transmission by way of ovary and infection of embryo during its development are variations of endogenous infection.

6R-1,1

STUDIES ON A CYTOPLASMIC POLYHEDROSIS VIRUS ISOLATED FROM EUXOA SCANDENS (NOCTUIDAE, AGROTINAE)

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A cytoplasmic polyhedrosis virus (CPV) was isolated from the larvae of the tobacco budworm Euxoa scandens (Quiot and Belloncik, 1977. Arch. Virol. 55: 145-153). The virus was successfully propagated in L. dispar cells in vitro. Studies were undertaken to evaluate the pathogenicity of CPV for E. scandens or other insects and the viral potential control of them. The effective doses 50 (ED50) of polyhedra produced in vivo and in vitro for different instars of the E. scandens larvae have been calculated. It also was found that the duration of larval stages in infected insects increased significantly with viral doses but duration of pupal stages was not affected. The infected pupae weighed less than the healthy ones and were frequently deformed. The effects of infection in adults were detected and the transmission of the virus to the next generation was demonstrated. A higher titer of polyhedra produced during a first passage in vitro of the virus, in comparison to one produced in vivo, was necessary in order to obtain 50% infection of the larvae. On the other hand, the physiological effects of the virus on the insects were similar for both sources of polyhedra.

Of 33 species of lepidopterous larvae fed in the laboratory with CPV polyhedra of E. scandens, 19 (including the economically important pests Euxoa messoria, A. C. nigrum and C. devastator) developped the characteristic cytoplasmic polyhedrosis disease. Furthermore insectarium studies on E. messoria demonstrated a larval infection rate of 96% under natural condition following infection with 10^7 polyhedra/m^2. These results could be of use in an integrated program control of pests important economically in our area. We evaluate presently in natural conditions the effects of CPV infection on the rate of mortality of E. scandens overwintering larvae and we study also in the same conditions the relations between the decrease observed in the weight of infected pupae and the fecundity of the adults.

6R-1,2

PROPAGATION OF HELIOTHIS ZEA SINGLE EMBEDDED BACULOVIRUS IN AN H. ZEA CELL LINE.

Yamada, K. and Maramorosch, K. (Waksman Inst. of Microbiology, U.S.A.)

The Heliothis zea single embedded baculovirus is highly pathogenic for the cotton bollworm or corn earworm, and it has been approved for large-scale use, but until now it has been produced solely by the insectary method, in living insects. The main reason for this type of production was the difficulty of maintaining the virus continuously in an H. zea cell line. This paper summarizes data concerning the replication and serial passage of H. zea SEV in an H. zea cell line. Serial passages were carried out with two virus sources. It was demonstrated that long-term serial passages of H. zea SEV in vitro decreased both the total number of PIBs produced and the infectivity of the supernatant as measured by $TCID_{50}$. The growth curve indicated that infectious material was released from cells 24 hrs p.i. and approached a maximal titer 3 days p.i. Electron microscopy confirmed the presence of single embedded virions in the inoculated cells.

6R-1,3

BACULOVIROSIS IN SPODOPTERA FRUGIPERDA LARVAE. SYMPTOMATOLOGY, HISTOPATHOLOGY AND PATHOGENICITY STUDIES.

Garcia, M., Andrade, C. and Habib, M. (Dept. Zool., State Univ. Campinas, Brazil).

In field as well as in laboratory conditions, NPV occurred in populations of Spodoptera frugiperda larvae. The environmental conditions during the epizootic were favorable (average of 27°C & 74% R.H.). The classic symptoms of NPV diseases were detected. Many histological alterations were observed at normal microscopical and ultrastructural levels. Fat tissues, salivary glands, malpighian tubes, tracheal matrix and epidermis were more suffered.

LTs and LDs analyses were carried out. With 1.8×10^6, 1.8×10^5 and 1.8×10^4 P/ml for 4th instar larvae, the LTs_{50} were 4, 11.2 and 28 days respectively. LD_{50}, LD_{70} and LD_{90}, 8 days after treatment for 4th instar larvae, were 3.28×10^3, 1.01×10^4 and 1.21×10^5 P/ larva respectively.

6R-1,4

ON THE PATHOGENIC CYTOPLASMIC-POLYHEDROSIS VIRUS(AFCPV) TO THE COMMON CUTWORM,*AGROTIS FUCOSA BUTLER*. Yasudomi, N. (Otsuka Chemical Co Ltd., Naruto Tokushima,772 Japan) and K. Ozaki (Kagawa Pref. Agr. Exp. Stn., Takamatsu Kagawa 761 Japan).

The common cutworm is a serious pest of vegetables in Japan. AfCPV was newly found from the pest in 1973. The two types of polyhedra were observed; one was hexahedron and the other was icosahedron. The polyhedra were found in the midgut epithelial cells. The size of polyhedra is 2.94±0.15μ. The particules with a regular hexagonal outline have 6 subunits with a projection at each corner and have icosahedron. Particules with a hexagonal outline have a diameter of 48.7±1.0mμ. 2nd instar larvae were the most susceptible of all instars (LC_{50} was 2.35×10^4polyhedra/ml). The susceptibility remarkably decreased as the larvae grew. LC_{50} for the 6th instar larvae were 6 times higher than that for the 2nd instar larvae. Infected larvae killed within 15 days after inoculation with AfCPV. The survival period of larvae infected with the virus came to shorter as environmental temperature increased. All of larvae inoculated with the virus were killed below 15°C, but 10 to 20 % of them survived above 20°C. 3rd instar larvae infected with the virus were remarkably delayed in growth as compared with control, and killed at 3rd or 4th instar. AfCPV was not pathogenic to *BOMBYX MORI*.

6R-2,5

MASS PRODUCTION OF THE GYPSY MOTH (LYMANTRIA DISPAR) NUCLEOPOLYHEDROSIS VIRUS
Shapiro,M. (U.S.D.A.-SEA/AR,Otis AFB,Mass., 02542 U.S.A.)

Research on optimization of gypsy moth nucleopolyhedrosis virus production resulted in more simplified and efficient procedures on a pilot plant scale. Many factors were identified and investigated for their influence upon both virus yield and virus activity. In addition, new processing methodology was developed, which resulted in a cleaner, less allergenic product.

As a result of these developments, costs were reduced over ten-fold to $2.00 or less per acre equivalent, and a large scale pilot plant production was initiated by the USDA and state gypsy moth control programs. More than fifty thousand acre equivalents of virus were produced from 1.5 million insects over a 100 day period.

6R-2,6

MICROBIAL CONTROL OF TWO CABBAGE PESTS, P. rapae AND P. xylostella USING TWO GRANULOSIS VIRUSES SEPARATELY AND IN COMBINATION.

Kao Shang-yin (Dept. Virology, Wuhan University, Wuchang, Hupeh, P.R.C.)

Cabbageworm, Pieris rapae and cabbagemoth Plutella xylostella cause serious damage to cabbage and other Cruciferous plants in China. It was found difficult to control them with chemical insectcides unless of course in high concentration. Two granulosis virses were isolated, one from cabbageworm and the other from cabbagemoth. The viruses as effective pesticide were tested in laboratory and in fields by using equous suspensions of the two viruses separately and in combination.

Trials were carried out in fields over the period 1978-1980. The efficiency of controlling the two pests by using these two viruses in combination was better than that by using each viruse separately. In the course of this work, we found a small non-capsulated viruse in association with cabbageworm viruse. Except it was found to be a DNA virus, as yet it has not been characterized.

6R-2,7 POSSIBLE UTILIZATION OF THE MIXED GRANULOSIS VIRUSES AS MICROBIAL CONTROL AGENTS OF THE LEAFROLLERS IN TEA PLANTATIONS.

Sato, T., Oho, N. (Fruit Tree Res. Stn., Yatabe, Ibaraki 305, Japan) and Kodomari, S. (Shizuoka Tea Exp. Stn., Kikukawa, Shizuoka 439, Japan)

The tea tortrix, *Homona magnanima* and the smaller tea tortrix, *Adoxophyes* sp. are important tea pests and pass four or five generations a year in Japan. Pest control of tea is now dependent upon broad-spectrum chemical insecticides, and this practice has brought forth several serious problems. As the development of highly selective control agents is important, we investigated the possibility of using granulosis viruses against these pests. Two kinds of viruses were isolated from the summerfruit tortrix, *A. orana fasciata* by Oho et al. (1974) and from *H. magnanima* by Sato et al. (unpb.), and mass-produced by the method described by Yamada and Oho (1973). After a mixed suspension of these viruses was sprayed once at the early stage of the first generation of the two pests, high rate of infection could be maintained up to the autumn generation. Thus, the inhihitory effect of virus spraying on the pest density was so high as to be equivalent to several applications of chemicals.

6R-2,8 TACHINIDS AS DISPERSAL AGENTS OF NPV IN POPULATIONS OF THE AMERICAN COTTON LEAFWORM, ALABAMA ARGILLACEA.

Andrade, C. and Habib, M.(Dept. Zool.State Univ.Campinas, Campinas,SP,13100,Brazil)

Biotic mortality factors in populations of Alabama argillacea were detected in cotton fields caracterized by favorable climatic conditions and absence of toxic pesticides. 7% mortality due to natural occurrence of NPV was observed. Tachinids, principally Patelloa spp. were considered as the principle dispersal agents of the virus . Parasitism of this group averaged 25%. Although 30% of these parasites did not complete its development (may be due to the inadequate nutritional conditions of the diseased host), we believe that it is compensable and useful for the maintenance and continuation of NPV in the field.

The relation between NPV and the tachinid parasites can be determined through ultrastructure examinations and susceptibility tests.

6R-2,9 APPLICATION OF PATHOGENS, HOST POPULATION DENSITY AND CROP DAMAGE INVESTIGATED IN A MODEL SYSTEM.

Entwistle, P.F., Evans, H.F., Harrap, K.A. and Robertson, J.S. (Unit of Invertebrate Virology, 5 South Parks Road, Oxford, UK).

For both chemical pesticides and insect pathogens the quantities applied to a crop determine the degree of protection. The modes of action are, however, very different: once acquired mortality from chemicals is relatively rapid but for pathogens death is preceded by a disease incubation period. This may vary from days to weeks during which much damage can be done. Thus simply killing large numbers of insects may give inadequate crop protection. An answer to the economic question "what dose of pathogen should be applied at a given host population density to prevent damage exceeding the economic threshold lies in understanding the interaction of host density - pathogen dose - level of crop protection. To investigate this pine sawfly (Neodiprion sertifer), its nuclear polyhedrosis virus (NPV) and Lodgepole pine (Pinus contorta) was employed as a simple system, the sawfly being univoltine and its larval period closely synchronised. Host density was manipulated before application of a range of NPV dosages in a replicated randomised block experiment. Protection was not directly proportional to dose as strong interactions occurred. For any one dose the quantity per larva of leaf consumed was related inversely to host density. This relationship applied across the whole of the dosage range tested. The general economic relevance of models based on this study is discussed.

6R-3,10

FOUR VIRAL PARTICLES FROM FLACHERIE-DISEASED SILKWORM, *BOMBYX MORI*.

Himeno, M.,(Dept. Agric. Chem., Kyoto Univ., Kyoto, 606 Japan)

Recently, several viral particles were isolated from flacherie-diseased silkworm larvae (*Bombyx mori*). A viral particle in them is a kind of densovirus and others belong to picornavirus. Four small RNA particles (FVS I, FVS IIa, FVS IIb, and FVS III) and FVS IV were isolated at various time after infection by sucrose gradient centrifugation. Also, they were separated by gel electrophoresis. At early stage of infection, FVS II, FVS III, and FVS IV were found from the larvae injected with FVS I or FVS II and FVS I was isolated at late stage. The purified virus were labelled with ^{125}I and they were repurified by the centrifugation or the gel electrophoresis. The ^{125}I-virus were dissociated and viral proteins were analyzed by PAGE. The maturation processes of FVS I are discussed and suggest as follows: FVS IIb → FVS IIa → FVS I.

6R-3,11

PRECIPITATION OF SILKWORM NUCLEAR POLYHEDROSIS VIRUS WITH A PROTEINOUS SUBSTANCE FROM THE SILKWORM DIGESTIVE JUICE.

Uchida, Y., Kawamoto, F., Himeno, M., and Hayashiya, K. (Lab. Biochem. Kyoto Technical Univ. Kyoto, 606 Japan)

It has been reported that the digestive juice of the silkworm larvae contains some low and high molecular anti-viral substances. A red fluorescent fraction which was isolated from the digestive juice had an anti-viral activity against silkworm nuclear polyhedrosis virus(NPV). It had also an activity to precipitate specifically with NPV at the optimum pH range and at the optimum concentration, like the antigen-antibody reaction.

On a CM-cellulose column chromatography, it was separated into two proteinous substances, one was red fluorescent and the other was non-fluorescent. The latter had an activity to precipitate with NPV but the former did not have. Both of them had an anti-viral activity.

The mechanism of the NPV precipitation with the proteinous substance will be discussed.

6R-3,12

AN ANTIVIRAL PRINCIPLE IN THE GUT-JUICE OF THE SILKWORM, *BOMBYX MORI*.

Funakoshi, M. and Aizawa, K. (Inst. Biol. Cont., Fac. Agr., Kyushu Univ., Fukuoka 812, Japan)

It is well known that a nuclear polyhedrosis virus in the infected hemolymph of the silkworm, *Bombyx mori*, is strongly inactivated *in vitro* at 27°C for 30 min with the gut-juice of silkworm larvae. After the dialysis of the gut-juice against 0.05 M carbonate buffer (pH 10.3) containing 0.1 M NaCl, a fraction which showed antiviral activity for non-occluded nuclear polyhedrosis virus was obtained by gel-filtration on Sephadex G-75 column equilibrated with the same buffer.

The antiviral activity of this fraction was not observed at pH range under 8.6 but was clearly demonstrated at pH 9.7. The antiviral activity was significantly inhibited by the addition of 10^{-3} M $HgCl_2$ or trypsin inhibitor from soybean.

Such properties were similar to those of gut-juice alkaline protease in the silkworm.

These results indicate that gut-juice alkaline protease is an antiviral principle in the inactivation of the virus.

6R-3,13 VIRUSLIKE PARTICLES OF CRYSTALLINE ARRAY IN MALE GERM CELLS OF THE MANTID HOLAPTILON PUSILLULUM.

Levanony, H., Wahrman, J. and Harpaz, I. (Hebrew University of Jerusalem, Israel)

Ultrathin sections through testicular tissue of the mantid Holaptilon pusillulum Beier revealed the presence of viruslike particles of crystalline array. The particles, in various phases of assembly, were observed in the cytoplasm of spermatocytes and spermatids as well as in somatic cells of the testicle. To the best of our knowledge, this is the first record of viruslike particles in a member of the family Mantidae. Moreover, the apparent occurrence of viral matter in male germ cells bears considerably on the possibility of transmission to progeny of virus deriving from the male parent rather than the female, which is the recognized mode of trans-ovum transmission. However, no conclusive evidence is yet available regarding the pathogenicity or viral nature of these particles.

6R-4,15 THE MODE OF ACTION OF THE TOXIC PROTEIN OF *BACILLUS THURINGIENSIS* T84A1 STRAIN ON SILKWORM AND MOUSE SARCOMA 180 ASCITES CELLS.

Watanabe,T., Abe,K., Tsutsui,R. and Seki,T. (Dept. of Food Science and Technology, Kyushu Univ., Fukuoka, 812 Japan)

The toxic protein of *Bacillus thuringiensis* T84A1 strain has the toxicity on lepidopterous larvae. The toxic protein was dissolved with the protease prepared from gut-juice of 5th instar silkworm larvae and the toxic fraction was partially purified with Shephdex G-75. By the medication of this toxic fraction to 5th instar silkworm larvae, mid-gut tissue cells, especially cylindrical cells were expanded and the inner substances of cells leaked out. Finally, mid-gut tissues were broken down to pieces. The toxin was also incorporated into mitochondria fraction of mid-gut tissues. Activities of succinate dehydrogenase and cytochrome c oxydase, *in vitro*, were inhibited at 50 to 60%. At that time, ATP synthesis, protein synthesis were also inhibited. The effects of this toxin on mouse sarcoma 180 ascites cells were investigated. A part of inner substances of sarcoma cells leaked out, especially leaking out of phospholipid was accelerated. Then after that, sarcoma cells were broken down to pieces.

6R-4,16 MODE OF ACTION OF BACILLUS THURINGIENSIS δ-ENDOTOXIN: EFFECTS ON INSECT AND MAMMALIAN CELLS IN VITRO.

Nishiitsutsuji-Uwo, J., Endo, Y. (Shionogi Res. Lab., Osaka, 553 Japan) and Himeno, M. (Dept. Agr. Chem., Kyoto Univ., Kyoto, 606 Japan)

TN-368 cells derived from the cabbage looper and Culex-cells developed from mosquitoes swelled and burst upon treatment with the dissolved δ-endotoxin of B. thuringiensis. Ultrastructures of swollen cells showed an enlarged nucleus, very scanty cytoplasm, condensed form mitochondria and vacuole-like endoplasmic reticula. Although similar swollen cells were observed with valinomycin treatment, some differences appeared on the ultrastructural level, especially in the mitochondria.

The cytotoxic effect of δ-endotoxin seemed to be a general breakdown of ion regulation on the cell level and seemed to be universal on the cells taken from insects in vitro. On the other hand, cells developed from mammalian origin, such as HeLa, KB, L and sarcoma-180, showed no morphological changes even at the ultrastructural level.

6R-4,17 MODE OF ACTION OF *BACILLUS THURINGIENSIS* δ-ENDOTOXIN: EFFECTS ON LEPIDOPTEROUS LARVAE *IN VIVO*.

Endo, Y. and Nishiitsutsuji-Uwo, J. (Shionogi Res. Lab., Osaka, 553 Japan)

The general pathology induced by *B. thuringiensis* in terms of larval behavior, hemolymph chemistry and histopathology have been widely studied on the so-called Type I, II and III insects. From species to species symptoms vary in succession from general paralysis to normal appearance. The degree of rise in pH and K^+ concentration of hemolymph was associated with symptomatic intensity as follows: *Papillio*≥*Bombyx*>*Samia*>*Pieris*>*Lymantria* > *Ephestia*. As to the ultrastructure of midgut epithelium, essentially the same histopathological changes were observed in the columnar cells of all six species, but changes in the goblet cells of *Lymantria* and *Ephestia* were different from those of the other four species.

From the results of bioassays using purest crystals and spores, we confirmed that crystals alone show high mortality even in *Ephestia* larvae. Spores seemed to play little or no essential role in the mortality of any of the six species.

6R-4,18 ELECTRON MICROSCOPIC STUDY ON CRYSTAL FORMATION OF *B. THURINGIENSIS* SPORELESS MUTANT.

Nishimura, M. and Nishiitsutsuji-Uwo, J. (Shionogi Res. Lab., Osaka, 553 Japan)

In order to investigate the formation of the parasporal crystal of *B. thuringiensis* with special reference to the spore, sequential ultrastructural analysis of sporulation was performed using a sporeless mutant strain (sp^-) as well as its parent wild strain (sp^+). From the logarithmic growth to the end of forespore formation, the same sequential process of sporulation proceeded in both strains and a forespore with double membranes appeared. Thereafter, subsequent sporulation in the sp^- strain was arrested and finally the spore became deformed. On the other hand, crystal formation was the same throughout all stages both in sp^+ and sp^- strains. During the forespore formation, a primordial crystal appeared, thereafter, the crystal displayed a characteristic diamond-shaped body. The crystal seemed to develop without any special association with the membranes of the spore. However, without the formation of the forespore or the incipient forespore, no crystal formation was observed.

6R-5,19 SEROLOGICAL GROUPING OF THE HEAT-STABLE SOMATIC ANTIGENS OF *BACILLUS THURINGIENSIS*.

Sekijima, Y., Ono, K., and Fujikura, Y. (Immunol. Div., Saitama Coll. Health, Urawa, 338 Japan)

Experiments were carried out to classify *Bacillus thuringiensis* by serological nature of heat-stable somatic antigens of vegetative cells. After the cultivation of *B. thuringiensis* at 30°C for 20 hr on nutrient agar, vegetative cells were harvested and suspended in physiological asline. Cells were heated at 100°C for 2 hr, washed 5 times with saline, and were used as heat-stable somatic antigens (HSSA). Antisera were obtained by immunizing rabbits with HSSA and agglutinated homologous heat-treated vegetative cells at titers ranging from 512 to 2048. Seventeen subspecies tested were classified into the following 13 major HSSA groups by reciprocal agglutination reactions, i.e., *thuringiensis*, *finitimus*, *alesti*-*darmstadiensis*, *sotto*, *dendrolimus*, *canadensis*, *subtoxicus*, *entomocidus*, *morrisoni*-*tolworthi*, *toumanoffii*, *thompsoni*, *kurstaki*-*galleriae*-*aizawai*, and *kenyae*. In addition to those major agglutinations, weak cross agglutination were observed among these 13 groups. This result was supported by agar gel precipitation reaction with water-soluble HSSA.

6R-5,21 EFFECT OF ANTIBIOTICS ON THE INSECTICIDAL ACTIVITY OF *BACILLUS THURINGIENSIS*.

ISHIGURO,T. and MIYAZONO,M.(Aburahi Lab.,Shionogi Co., Shiga, 520-34 Japan)

Insecticidal activity of *Bacillus thuringiensis* was mainly exhibited to lepidopterous larvae, but its activity was influenced by some antibiotics(Somerville et.al.,1970, Ignoffo et.al., 1977).

Erythromycin among several antibiotics tested in our experiments showed the strongest inhibition of the insecticidal activity to the silkworm(*Bombyx mori*) and the pine caterpillar(*Dendrolimus spectabilis*). On the basis of this observation, we examined the mode of action of Erythromycin on the toxic activity of *Bacillus thuringiensis* var.*kurstaki* to the silkworm.

6R-5,22 CONTROL OF THE GIANT LOOPER *BOARMIA* (*ASCOTIS*)*SELENARIA* SCHIFF. (LEP.:GEOMETRIDAE) IN AVOCADO ORCHARDS BY MEANS OF *BACILLUS THURINGIENSIS* BERLINER PREPARATIONS.

M. Wysoki[1] and Y. Izhar[2] ([1]Div. Ent., Agric. Res. Org. Bet Dagan; [2]Ministry of Agr., Extension Service, 'Akko, Israel).

In Israel aerial sprays of cotton fields adjacent to avocado orchards upset the biological equilibrium within the groves and result in outbreaks of the Giant looper. Therefore biology, phenology as well as natural enemies of this pest were studied. Since in Israel, biological control of avocado pests is used exclusively, *B. thuringiensis* preparations are being sprayed against *B. selenaria* larvae. Virgin female traps are used for monitoring because,only young larvae are sensitive to *B. thuringiensis*. The *B. thuringiensis* preparations used are harmless to *Hungariella peregrina* Compere and *Anagyrus fusciventris* (Hym.:Encyrtidae) which parasitise *Pseudococcus longispinus* Torgioni Tozzetti (Hom.:Pseudococcidae), on the other hand these preparations are effective against another avocado pest:*Cryptoblabes gnidiella* Mill. (Lep.:Phyticidae).

6R-6,23

A FUNCTION OF PLASMIDS IN *BACILLUS THURINGIENSIS*

Kanda, K., Katsuki, M. and Aizawa, K. (Inst. Biol. Cont. Fac. Agr., Kyushu Univ., Fukuoka 812, Japan)

The function of plasmids of *Bacillus thuringiensis* was investigated using mutants of *B. thuringiensis* subsp. *alesti*. Parent strain (PC$^+$) formed pink colonies and produced crystals on G-medium agar plate. For the analysis of the biological function of plasmids,a crystalliferous mutant (WC$^+$) which formed white colonies on G-medium agar plate was obtained from PC$^+$ by NTG treatment and an acrystalliferous spontaneous mutant(WC$^-$) which formed white colonies was obtained from PC$^+$. Plasmids of these strains were extracted using a cleared lysate method and purified through ethidium bromide-CsCl density gradient ultracentrifugation. The gel electrophoretic pattern of plasmids in WC$^+$ was identical to that of PC$^+$. However, WC$^-$ did not possess the smallest plasmid molecule among four plasmids which were detected in PC$^+$ and WC$^+$. These evidences suggest that at least one plasmid concerns with the production of crystals in *B. thuringiensis* subsp. *alesti*.

6R-6,24

SELECTION OF *BACILLUS THURINGIENSIS* SEROTYPE 10 STRAINS FOR THE MOSQUITO CONTROL

Ohba, M., Padua, L. E., and Aizawa, K. (Inst. Biol. Cont., Fac. Agr., Kyushu Univ., Fukuoka 812, Japan)

Three unusual isolates of *Bacillus thuringiensis*, designated as 73-E-10-2, 73-E-10-16, and 74-E-37-14, were obtained from the silkworm litters of the sericultural farms in Japan. Flagellar antigens of these isolates were completely identical to that of the reference strain of *B. thuringiensis* serotype 10 (subsp. *darmstadiensis*). Heat-stable somatic (O) antigen of the strain 73-E-10-2 was identical to that of the strain 73-E-10-16. The strain 74-E-37-14 and the reference strain of serotype 10 had the specific O antigens, respectively. Differences were also observed between isolates and the reference strain in the production of enzymes such as lecithinase, DNase, arginine decarboxylase, acid production from inulin, and the utilization of malonate. No heat-stable fly toxin was detected in these three isolates. The strains, 73-E-10-2 and 73-E-10-16, produced spherical parasporal inclusions highly toxic to larvae of the mosquitoes, *Aedes aegypti*, *Culex molestus*, and *Culex tritaeniorhynchus*, but nontoxic to the lepidopterous larvae. The LD$_{50}$ of these isolates for the mosquito species was 10^4-10^5 spores/ml. The strain 74-E-37-14 produced large parasporal inclusions nontoxic to the larvae of both orders. Parasporal inclusions of the reference strain of serotype 10 was typically diamond-shaped and showed the toxicity to only lepidopterous larvae. These results indicate that *B. thuringiensis* serotype 10 can be divided into 3 groups from the viewpoint of the toxicity to the lepidopterous and dipterous insects and also indicate that the two strains, 73-E-10-2 and 73-E-10-16, are the potential candidates for the mosquito control agent.

6R-6,25

SPECTRA OF ACTIVITY OF *BACILLUS THURINGIENSIS* AND DEVELOPMENT OF MORE EFFICACIOUS STRAINS.

Beegle, C. (USDA-SEA-AR, Brownsville, Texas, USA)

Many of the *B. thuringiensis* serotypes show distinct patterns of activity towards different insect species. Activity patterns towards *Agrotis*, *Spodoptera* and *Heliothis* species will be discussed as well as progress to date on development of a superior strain for use against *Heliothis* sp.

6R-6,35 ENGINEERING ASPECTS OF MICROBIAL INSECTICIDE APPLICATIONS

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Results on the effects of applied dose, spray droplet size, deposit density (no. drops/unit area) and Bacillus thuringiensis (Bt) concentration on insect mortality will be discussed. Equipment aspects of field applications with microbial insecticides will also be presented. A discussion of recent studies on the loss/redistribution of suspension particles (spores, crystals, etc.) will also be included in this presentation. Other recent research results to be discussed will include the effect of liquid pressure and shear on Bt spores and crystals, the influence of single and multiple ingredients on development of a microbial insecticide bait and the effect of liquid modifiers (thickeners, UV pro-tectants, surfactants, sugars, etc.) on microbial insecticide application and insect control.

6R-7,26 RESULTS OF LABORATORY AND FIELD STUDIES USING Neoaplectana carpocapsae and Beauvaria bassiana AS MICROBIAL INSECTICIDES AGAINST THE COWPEA CURCULIO.

Russell, Charles E. (Institute of Ecology, Univ. of GA, Athens, GA, 30602, U.S.A.)

The nematode, Neoacplectana carpocapsae and the fungus Beauvaria bassiana we tested as microbial insecticides against the cowpea curculio, Chalcodermus aeneus Boheman, in the laboratory and in small field plots. The LC_{50} for both the lab and field were determined for single applications of these agents. The results indicate the fungus and/or the nematode may be useful in managing this insect pest in irrigated crop systems.

6R-7,27 PURIFICATION OF SPORES OF NOSEMA BOMBYCIS BY URÓGRAFIN DENSTIY GRADIENT CENTRIFUGATION

Kawarabata,T.,Aratake,Y., and Fujiwara,T. (Inst. Biol. Cont., Kyushu Univ., Fukuoka,812 Japan)

Microsporidian spores have been liberated from infected tissues of insects after trituration of dead insects in distilled water. Usually, various contaminating materials including fragments of insect tissues, gut contents,fungi and bacteria were observed in spore suspensions. Density gradient centrifugation of spores of Nosema bombycis on gradient made from sucrose,Ficoll(Pharmacia, Sweden) and Percoll (Pharmacia,Sweden)resulted in unsatisfactory separation of spores from bacteria, the major contaminant. An efficient method was needed for further purification of spores of N. bombycis. A new method was developed by using a density gradient made from Urografin 76 (Shering AG, West Germany). Partially purified spores were suspended in distilled water (ca. 10^8 spores/ml) and the suspension was layered on a linear 40-70 % (v/v) Urografin 76 gradient in distilled water pH 7.4. After centrifugation at 67,976 g in a Spinco SW 41 Ti rotor for 30 min at 4°C, a major band was formed at the midst of the gradient. Sometimes a minor band was observed near to the top of the gradient. Bands formed in the gradient were drawn off with a syringe and these fractions were washed twice with distilled water to remove Urografin. A major band contained only spores of N. bombycis under the microscopic inspection. Bacteria remained near the top of the gradient. Spores appearing dark in phase contrast microscopy were found from a minor band with a small number of bacteria. Spodoptera frugiperda cells (Sf 21 AE II) were infected with spores of N. bombycis purified by Urografin density gradient centrifugation and infected cultures of S. frugiperda cells were established.

6R-7,28 RESISTANCE OF MICROPLITIS MEDIATOR EGGS AND LARVAE TO HEMOCYTIC ENCAPSULATION BY THEIR NATURAL HOST, LEUCANIA SEPARATA.

Tanaka, T. (Dept. Zool., Kyoto Univ., Kyoto, 606 Japan)

The egg and larva of the solitary parasitoid, Microplitis mediator oviposited within its natural host are not encapsulated. Works were undertaken to know whether parasitoid egg itself or larva itself possesses the ability to avoid encapsulation reaction of the host. The relationship between calyx fluid and encapsulation reaction by the host was also examined. The egg deposited into normal host reaches serosal stage within 24 hrs and 1st instar in two days. When a parasitoid egg immediately after deposition was transferred into non-parasitized host, 40% of 12 eggs injected normally hatched without evoking encapsulation.

Larva with serosa completed, or immediately befor hatching, or immediately after hatching was transferred into a host with or without calyx fluid. In all cases the larvae evoked encapsulation within 24 hrs. However, when 1st instar larva was transferred into the host which had been infected with calyx fluid 24 to 48 hrs before, the proportion of the larvae encapsulated was reduced by half. The results indicate that calyx fluid is involved in host regulation mechanisms.

6R-7,29 INSECT'S PHYSIOLOGICAL STATE: METHODS OF EVALUATION AND USING FOR PEST FORECASTING.

Pristavko V.P. (Div. Zool. & Parasitol., Byelorus.Acad.Sci.,Minsk,USSR)

Available methods of insect's physiological state evaluation or establishing a degree of its resistance against different injurious factors are analysed for its integrality, sensitivity, operativity, standardity and informability, with special reference to haematological analysis and electrophysiological assessment of olfactory sensibility (EAG study).

6R-8,30 **Susceptibility of the yellow-spotted longicorn beetle, Psacothea hilaris** Pascoe, to infection with an entomogenous fungus, Beauveria tenella(Delacroix)Siemaszko.

K.Kawakami and Shimane, T.(Sericultural Experiment Station, Oowashi-1, Yatabe-machi, Tsukuba-gun, Ibaraki, 305 Japan)

The yellow-spotted longicorn beetle, Psacothea hilaris Pascoe, is one of great harmful insects to the mulberry tree in Japan, but we have no effective control methods for them. The author have been performed some field and laboratory experiments with entomogenous fungi to know the possibility of microbial control.

There were many natural infection of the adult beetles with Beauveria tenella(Delacroix)Siemaszko in mulberry fields. The fungus B.tenella was more infectious to the beetles than other entomogenous fungi. The beetles well infected with B.tenella by inoculation to legs or antennae only. Young adult beetles were more susceptible than old ones to B.tenella infection. On the other hand, there was no difference in the susceptibility of the male and fewmale insects to B.tenella. These results suggest that B.tenella is one of the effective natural pathogen associate with the beetles in the field and that it is necessary to apply the fungus B.tenella for the beetles as microbial control agent.

6R-8,31 OBSERVATIONS ON ENTOMOPHTHORACEOUS FUNGI ATTACKING APHIDS IN JAPAN.

Nemoto, H. (Saitama Horticul. Exp. Stat., Saitama 346, Japan).

Of seven entomophthoraceous fungi attacking aphids collected, *Entomophthora aphidis*, *E. extialis*, *E. sphaerosperma*, *E. major*, *E.* sp. and *Conidioborus coronatus* were succesfuly isolated on egg dextrose agar (EDA). On the other hand, isolation of *E.* sp. near *fresenii* was unsuccessful. The isolates (*E. aphidis* and *E. sphaerosperma*, and *C. coronatus*) on EDA and *E.* sp. near *fresenii* on the aphid were observed by means of scanning electron microscopy.

6R-8,32 PATHOGENICITY OF DIFFERENT NATURAL ISOLATES OF *HIRSUTELLA THOMPSONII* TO THE CITRUS RUST MITE, *PHYLLOCOPTRUTA OLEIVORA* (A.).

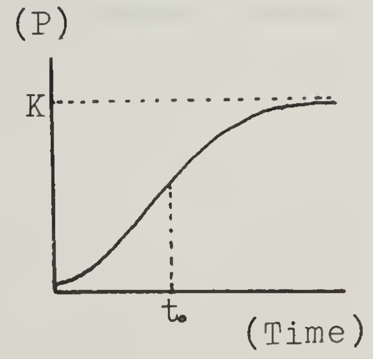
McCoy, C. and Boucias, D. (Univ. Fla., IFAS, Agric. Res. & Ed. Ctr., Lake Alfred, FL 33850 USA)

A series of bioassays was performed with a number of natural isolates of the mite pathogenic fungus, *Hirsutella thompsonii* using adult citrus rust mites and adult strawberry spider mites, *Tetranychus turkestani*. Inoculum was grown on soil fungus medium for 10 days at 26-27°C. Conidia were washed off the surface of the agar in sterile distilled water for immediate testing. Three dosages were used for each assay in the range of 10^5-10^7 conidia/0.02 μl of sterile distilled water. LD_{50} and LT_{50} values for 14 different isolates indicate some difference in potency between isolates although variability of the data within assays was considerable.

6R-8,33 THE SPREAD OF THE *ASPERGILLUS* DISEASE IN HOST POPULATIONS OF THE SILKWORM, *BOMBYX MORI*.

KUNIMI, Y. (Div. Sericult. Exper., Tokyo Sericult. Consult. Center., Tokyo, 197 Japan)

The *Aspergillus* disease occasionally causes serious damage to Japanese sericulture. To determine the process of the dissemination of this disease, some laboratory experiments were conducted. The results showed that the rate of *Aspergillus* infection (P) can be represented by the Verhulst-Pearl logistic equation as follow: $P = K / \{1 + \exp[-r(t - t_0)]\}$. The pattern of the curve was influenced by the initial density and the developmental stage of the silkworm larvae.



6R-8,34 INTERACTION BETWEEN PESTICIDES AND THE ROLE OF MICROORGANISMS IN THE GUT OF THE COTTON LEAFWORM SPODOPTERA LITTORALIS (BOISD.), ABOUL-NASR, A.E. and Shaheen (Dept. of Entomology, Faculty of Science, Cairo University).

From the midgut of last-instar larvae of S. littoralis, two species of fungi namely Penicillium cyclopium (Westling) and P. chrysogenum (Thom) were isolated from S-strain, Matacil-resistant (R_m) and Fenitrothion-resistant (R_f) strains. From R_m strain, Aspergillus unguis (Emil-Weiland-Gaudian) Thom and Church was also isolated. Treatment with insecticides caused in vivo and in vitro inhibition of fungal growth. The three species of fungi exhibited the ability to digest cellulose.

6P,1 FARGUES J., RODRIGUEZ, Dora and VOEGELE, J. (INRA Lutte Biologique, 78280 GUYANCOURT, France)

SUSCEPTIBILITY OF NOCTUIDS EGG MASSES TO NOMURAEA RILEYI AND PAECILOMYCES FUMOSO-ROSEUS

Hyphomycete pathogenicity for egg stage of Noctuids was investigated by contamination of Mamestra brassicae and Spodoptera littoralis with Paecilomyces fumoso-roseus and Nomuraea rileyi at 20° and 25°C. It was demonstrated that P. fumoso-roseus 39 was capable of producing mortality during the egg stage of Noctuids. The pathotype N. rileyi 5, highly virulent to S. littoralis larvae (FARGUES and Rodriguez, 1980), did not kill eggs but it provoked only a deferred mortality of larvae hatched from treated eggs. S.E.M. observations suggested two ways of infection of newly hatched larvae. On the one hand, fungal germinations (germ tubes or appressorial structures) on chorionic surface showed that newly hatched larvae might be contaminated by penetration through egg cuticle before hatching as it was investigated in the case of larval infections during molt (FARGUES and VEY, 1974 ; Zacharuk, 1974 ; VEY and FARGUES, 1977). On the other hand, S.E. micrographs showed conidia on mouthparts of newly hatched larvae that must be contaminated by feeding the treated chorion.

6P,2 NATURAL OCCURRENCE OF NOMURAEA RILEYI IN POPULATIONS OF SPODOPTERA FRUGIPERDA WITH SOME SUSCEPTIBILITY STUDIES. Habib,M. and Patel,P.(Dept. Zool.,Univ.Campinas, Campinas,13100,Brazil).

Epizootics caused by Nomuraea rileyi were observed in populations of Spodoptera frugiperda larvae in corn fields (State of Sao Paulo,Brazil). The disease occurred during the months of January and Fedruary, 1979 when the climatic conditions were in an average of 29°C and 78% R.H. Under laboratory conditions , susceptibility tests were carried out utilizing 5.29×10^5 spores/larva. LT_{50} of 5th instar larvae was calculated as 9 days. Temperature and relative humidity were almost similar to the field conditions.

Corn fields near to soybean fields or in rotation with the latters showed more frequency of micosis caused by N. rileyi than isolated fields.

6P,3

ELECTROPHORETIC ANALYSIS OF THE HYDROPHILIC PROTEINS OF HIRSUTELLA THOMPSONII: ISOZYME DIFFERENTIATION OF THE H. THOMPSONII ISOLATES. Boucias, D. and McCoy C.(Univ. Fla., IFAS, Agric. Res. and Ed. Ctr., P. O. Box 1088, Lake Alfred, FL 33850 USA)

Hydrophilic enzymes were extracted from mycelial preparations of natural isolates of the pathogenic fungus, *Hirsutella thompsonii*. Analysis of these preparations using the SDS-PAGE system demonstrated a complex mixture of proteins. The large number of bands present prevented accurate resolution between the different isolates. Many of the major proteins of the *H. thompsonii* isolates did comigrate. Zone electrophoresis combined with specific histochemical techniques was thus adopted to characterize the enzymes present in the various *H. thompsonii* preparations. A continuous tris-glycine (pH 8.9) buffer system was superior to the tris-citrate (pH 7.0), tris-citrate (pH 8.2), lithium hydroxide (8.45), and tris borate + EDTA (pH 8.8) buffer systems in resolving the hydrophilic fungal proteins. Optimum separation was achieved at a constant power of 10W per slab and a total run time of 3 hr. Multiple isozymes were located in eight out of the ten enzyme systems tested reflecting a great deal of heterogeniety in the *H. thompsonii* mycelium. The zymogram technique was adapted to analyze differences between the fungal isolates. The electromorph pattern of specific enzyme systems have been used to identify specific *H. thompsonii* isolates. A phenogram, generated through an analysis of the coefficient of similarities between paired isolates was used to infer relationships between the various *H. thompsonii* isolates.

6P,4

BIOLOGICAL EFFECTS OF *BACILLUS THURINGIENSIS* IN THREE LEPIDOPTEROUS INSECTS.

Salama, H. Foda, M. and sharaby, A. (National Research Centre, Dokki, Cairo, Egypt).

Investigations have been made on the biological effects of sublethal doses of *Bacillus Thuringiensis* in the form of commercial thuricide in the three lepidopterous species namely *Spodoptera littoralis*, *Spodoptera exigua* and *Heliothis armigera*. This was made by incorporating various concentrations of thuricide in the artificial diet fed to the hatching larvae. The concentrations used varied with the tested species but they were within the range of 3 - 830 microgram / ml of the diet used. Observations showed an obvious retardation in larval development, reduction in pupal weight with some deformities, reduction in adult emergence and increase in the moth deformities. The fecundity of the moth was significantly reduced but no effect was obtained with egg hatching or the longevity of the survived moths.

6P,5

THE EFFICACY OF *BACILLUS THURINGIENSIS ISRAELENSIS* AGAINST MOSQUITO AND NON-TARGET ORGANISMS IN THE UPPER RHINE VALLEY (F.R.G.). Schnetter, W., Aly, C., Engler, S. and Morawcsik, J. (Inst. Zool., Univ. Heidelberg, D-6900 Heidelberg, F.R.G.)

Our investigations on *Bacillus thuringiensis israelensis* (B.t.i.) confirm that the endotoxin from B.t.i. is selectively active against larvae of some families of Nematocera. Besides the Culicidae and Simuliidae, the Chironomidae are also sensitive. The LC_{95} values for the final larval stages of *Aedes vexans*, *Ae. communis*, *Ae. punctor*, *Culex pipiens* and *Chironomus spec*. range from 10^3 to 10^4 spores/ml, and for the first larval stages as much as 100-fold lower. The B.t.i. toxin has either no effect on other Nematocera (Chaoboridae) or begins to have an effect only with a spore titer of 10^7/ml (Tipulidae). All other water fauna remain aneffected by even this high titer of spores (10^7/ml). As has been found previously for other strains of *Bacillus thuringiensis*, safety tests on mammals showed no side effects.

We report on the effectiveness of a B.t.i. formulation which confines the toxin mainly to the water surface and hence avoids damage to Chrinonomidae. *Bacillus thuringiensis israelensis* is also eminently suited for use in mosquito control in the Upper Rhine valley.

6P,7 COMPATIBILITY AND SYNERGISM BETWEEN BACILLUS THURINGIENSIS VAR. KURSTAKI AND CHEMICAL INSECTICIDES.

Habib,M. and Garcia, M.(Dept. Zool. State Univ. Campinas, Campinas,SP,13100, Brazil).

Germination and growth rates of Bacillus thuringiensis var. kurstaki were measured in artificial medium containing chemical insecticides. Methyl parathion was highly compatible with the bacterium. The higher concentrations of this chemical (1.88 and 3.75 ppm) enhanced the bacterial germination and reproduction. Pyrethroid was also found to be compatible with the bacterium. Concentrations of 1.44 ppm at pH 6.3 and 2.89 ppm at pH 8.6 of pyrethroid stimulated bacterial germination.

The susceptibility of Spodoptera frugiperda larvae was determined for the bio-insecticide when combined with either of the two chemical insecticides. The organophosphorus compound as well as pyrethroid showed inapparent antagonism with the pathogen. When the two chemicals were combined, methyl parathion increased the toxicity effect of pyrethroid against S. frugiperda larvae.

6P,8 ENTOMOPATHOGENIC MICROORGANISMS IN THE FOREST PROTECTION AND QUESTIONS OF THE FOREST BIOCENOSIS CONTAMINATION

Gukasyan A.B., Sorokina A.G., Mashanov A.I., Gukasyan V.M. Forest and Wood Institute, Academy of Sciences, State University, Krasnoyarsk, USSR.

Crystalliferous entomopathogenic microorganisms are efficiently used in the integrated plants protection. The apply of the following preparations: insectin and tuverin causes a high mortality of lepidopterous larvae and pupae. The introduced pathogen adapts to the forest biocenosis forming constantly functioning centres of infection, causing the death of the newly appeared phytophagans and reducing the quantity of insects to the level which does not have any economic importance. Metabolites of Bac.insectus and Bac.tuviensis contain the complex of vitamins and aminoacids, phytohormones of auxin and phenol nature. The important role of the metabolite components of the crystalliferous bacteria in the trophic picture of the wood vegetation is experimentally proved. Pathogens introduced into the forest biocenosis do not change the qualitative and quantitative composition of microflora, its enzymatic properties and do not contribute to the forest biocenosis contamination.

6P,10 PROPERTIES AND STRUCTURE OF DENSONUCLEOSIS VIRUS OF THE SILKWORM, BOMBYX MORI.

Kawase,S. and Nakagaki,M. (Fac. Agr., Nagoya Univ., Nagoya 464 Japan)

A densonucleosis virus, which was designated as "Ina-flacherie virus" was isolated from the silkworm, and the properties of its DNA and protein were characterized. The DNA was single stranded (ss), but under condition of appropriate high salt and elevated temperature, double-stranded (ds) DNA was extracted by annealing. Electron microscopical (EM) examination revealed that the ds DNA was composed of linear molecule with an average length of 1.7 μm. The molecular weight (MW) of the viral ss DNA determined by EM and agarose gel electrophoresis was 1.7×10^6 daltons. Four structural proteins were found in the virion by SDS-polyacrylamide gel electrophoresis. The major viral protein (VP1), which is believed to be capsid protein, had a MW of 50,000, and a particle contains about 60 molecules of VP1. From negatively stained preparation of virion on each of the three axes of symmetry, 2, 3 and 5, it is suggested that the single virion has twelve subunits being consisted of pentamer of VP1.

6P,11 EFFECT OF A HIGH TEMPERATURE ON INCIDENCE OF CYTOPLASMIC POLYHEDROSIS OF THE SILKWORM, BOMBYX MORI L., Miyajima, S. (Aichi-ken Agric.Res.Centr., Aichi, 480-11 Japan)

When larvae were reared at a high non-permissive temperature (35C) after being inoculated per os with CPV, the rate on the incidence was lowered at a high temperature as compared with the case at permissive temperature (25C). At 35C rearing after CPV inoculation the refractive index of the hemolymph of the larva increased gradually the same as controls. SEM examination revealed the remarkable formation of polyhedra in section of midgut at 25C, whereas could not find it at 35C after inoculation. When examined by XMA on the midgut epithelium the peak of P and S showed the same level at 35C and controls, but in the midgut of infected larvae at 25C the peak of P was higher than that of S. The results show that CPV replication is apparently surpressed at a high temperature.

6P,12 EXPERIMENTAL INFECTION OF ODONTOTERMES HORNI WITH PLEISTOPHORA GANAPATII. Kalavati, C. and Narasimhamurti C.C. (Dept. of Zool., Andhra Univ. Waltair)

Spores of Pleistophora ganaptii suspended in 1% glucose solution were fed to infection-free nymphs, soldiers and workers in batches of 25 maintaining proper controls. Termites were examined at hourly intervals for the first 6 hours and thereafter every 12 hours. Groups of spores, some of which released polar fialemnts were seen in the foregut 10-15 minutes after infective meal. Amoebulae penetrating the epithelial cells were not observed. Contents of the spores found in the faeces in about 2-3 hours after infective meal were stained but their polar filaments were not released by the usual methods. Small bi- and tetra-nucleate stages were observed in the epithelial cells after 72 hours. Majority of termites died between 80-96 hours and 85% of the dead termites showed developing pansporoblasts. All termites died in 120 hours due to infection. Nymphs were more susceptible for infection. Soldiers did not pick up infection although they ingested spores. The host cell and the host cell nucleus in infected cells were hypertrophied. The cytoplasm was highly vacuolated and the chromatin of the nucleus was dispersed in the nucleoplasm. Infected epithelial cells over large areas were burst and released spores which blocked the passaage between the foregut and midgut which perhaps accounts for the death of the termites.

6W-1,1 ASSESSMENT OF THE OCCURRENCE OF VIRUS INFECTIONS IN INSECT POPULATIONS. Hukuhara, T. (Fac.Agric., Tokyo Univ.Agric.Technol., Fuchu, 183 Japan)

The occurrence of virus infections in insect populations can be measured by diagnosing sampled individuals. However, the method is time-consuming and the resulting data are complicated by large sampling errors. Moreover, the removal of individuals for diagnosis may disturb the natural progress of the epizootic. We should develop other methods which may replace or supplement the above method. Feces, dust and soil which are collected in insect habitats are often contaminated with viruses. They can be used to estimate the occurrence of virus infections in insect populations. Bioassay is an established method for detecting viruses in such materials. However, purification of the viruses and serological identification has the following advantages: (1) the results of assessment are obtained quickly; (2) the virus properties are characterized; and (3) not only active but also inactive viruses are detected.

6W-1,2 THE ROLE OF FOLIAR RESIDUES OF NUCLEAR POLYHEDROSIS VIRUS IN EPIZOOTICS IN EUROPEAN SPRUCE SAWFLY, GILPINIA HERCYNIAE.

Entwistle, P.F., Evans, H.F. and Adams, P.H.W. (Unit of Invertebrate Virology, 5 South Parks Road, Oxford, UK).

The full development of Gilpinia hercyniae (Hymenoptera:Diprionidae) nuclear polyhedrosis virus (NPV) disease epizootics requires the elapse of several host generations. Being a temperate zone species host generations are discontinuous creating the need for NPV to survive an 8 month period between successive larval phases. In Wales though NPV applied experimentally to trees decayed biologically to background levels in 4-5 months and the physical half life of polyhedra on foliage was only 55 ± 19 days, under natural conditions effective quantities of inoculum survived, probably by progressive release from decaying larval corpses. The relationship of inoculum surviving to the beginning of each larval season (measured by bioassay) and the pattern of infection growth in the larval populations was studied for 6 years. The quantity of foliar NPV determined the speed of growth of infection in the larval population and was a major factor in the epizootic process. The relationships of foliar inoculum and NPV persisting in other ways to the total epizootic process is considered.

6W-1,3 Principles of Epizootiology of Bacterial Disease

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Of all the insect pathogenic bacteria three principle groups stand out. They are the Bacillus popilliae (& Lentimorbus) group, the B. thuringiensis group and the B. sphaericus group. The Temporal and Environmental parameters that instigate epizootic within each group as well as the characteristics of the epizootics themselves are distinctly different. This is a result of the character of each pathogen group. There occurs also variation in epizootology within the groups. In these cases the differences are the result of biological differences between host populations, densities and the pecularities of the host environment.

6W-1,4 DISPERSION AND PERSISTENCY OF ENTOMOPHTHOROUS FUNGI IN AN INSECT POPULATION

Aoki, J. (Facult. Agr., Tokyo Univ. Agr. Tech., Tokyo, 183 Japan)

The conidial dispersion of Entomophthora grylli type began before the outbreak of the epizootics in population of Aedia leucomelas larvae. Rain induced the dispersion and germination of the conidia. The conidia discharged from 4 to 40 hr after the death of the larva. The discharge was found to be greater in the night time than in the day time, but it was independent of light condition. The conidia of E. aulicae were formed on Lymantria dispar larvae in young stages, and the resting spores were formed in older stages during summer. The resting spores hibernated in the egg mass of the gypsy moth, and a few spores germinated. E. floridana formed resting spores in Oligonychus hondoensis adults during winter. No resting spore formation has been observed on E. blunkii in Plutella maculipennis larvae and on some Entomophthora species infecting aphids. The behavior of an insect seems to be related to the resting spore formation of entomophthorous fungi.

6W-1,5 PRINCIPLES OF EPIZOOTIOLOGY OF NEMATODE INFECTIONS. Kaya, H.K. (Div. Nematology, University of California, Davis, California, 95616, USA

The nematode, Heterotylenchus autumnalis, parasitizes the face fly, Musca autumnalis. Except for a brief free-living stage, the life cycle of the nematode occurs entirely within the host alternating between gamogenetic and parthenogenetic stages. The population dynamics of the face fly and the incidence of nematode infection have been studied in a California pasture. The adult fly abundance showed that fly populations were highest in late May, declined to a midsummer low in early August and reached a smaller second peak by early October. Incidence of nematode infection (18-41%) was highest from late May through mid-July and then flucuated between 6 and 13% until early October. The decline in fly population and nematode infection during the summer is probably due to the warmer temperatures. The effects of temperature and moisture on nematode development and infection of insects in relation to epizootics will be discussed.

Section 7.

Behavior.

7S-1,1 SOME NUTRITIONAL REQUIREMENTS OF THE LARGE MILKWEED BUG (ONCOPELTUS FASCIATUS).

Auclair, J.L. (Dept. Biol. Sci., Univ. de Montréal, Montréal H3C 3J7, Canada)

Studies on the nutritional requirements of the large milkweed bug maintained on milkweed seed and water were carried out with the use of chemically defined diets. Larvae reared singly on such diets showed poorer growth and survival when compared to those reared in groups of ten or less. Of fourteen carbohydrates tested, arabinose and rhamnose were of poor value, whereas glucose, sucrose or melezitose provided best growth at about 4%, a higher or lower concentration giving poorer growth. The presence of ten amino acids usually considered essential for insects resulted in significantly improved growth of third instar larvae, when compounds were tested singly, but had little effect on survival. Larvae could tolerate a rather wide range in the dietary concentration of each essential amino acid, but total amino acid concentration was optimal at about 3.6% for growth and reproduction. Results on certain modifications in the chemical composition of a basal diet for improved performance by the bug are also presented.

7S-1,2 DIURNAL CHANGES IN APHID NUTRITION.

van EMDEN, H.F. (Dept. Agric & Hort. and Zool, Reading, Univ., England)

Aphids can regulate their feeding, and thus can to some extent compensate for periods spent on inferior diets. Long periods on inferior diets may result in better diets later not being fully utilised. The plant provides a continuous diurnal alteration of rich and dilute diet, and it appears that the latter may be important in enabling the aphid to exploit the former. The results of these studies on the diurnal feeding of aphids has implications for the use of synthetic diets.

7S-1,3 HOST PLANT EFFECTS ON WING DIMORPHISM IN APHIDS.

Harrewijn, P. (res. Inst. for Plant Prot., Wageningen, The Netherlands.

Wing dimorphism in aphids is connected with generation succession, with host alternation, or, in the case of new-born larvae, can be expressed within one generation. All three "types" are governed by both extrinsic and intrinsic factors. It is unknown, however, whether or not the same regulatory system operates in all types. A number of extrinsic factors such as some host plant substances are now known. Given the fact that regulation of wing dimorphism in the parthenogenetic generations of Myzus persicae is both maternal and larval, differences in response between mother and daughter can be used to elucidate the regulatory system of wing dimorphism in reproducing females and in larvae. The above mentioned relationships particularly hold for some cyclic amino acids and a few trace elements. The results are discussed on a neurosecretory basis of polymorphism in aphids.

7S-1,4 DIGESTIVE ENZYMES AND TREHALASE ACTIVITY IN SOME HEMIPTEROUS INSECTS AND THEIR RELATION TO INSECT HOST COMPATABILITY AND INSECT BEHAVIOR.

Ishaaya, I., Swirski, E. and Neubauer, I. (Div. Entomol. Volcani Center, ARO, Bet Dagan, Israel)

The invertase activity of both Florida red scale (Chrysomphalus aonidum) and California red scale (Aonidiella aurantii) was much greater than that of amylase; no protease activity was detected. Various host plants have a slight effect on the Florida red scale invertase but not on that of California red scale. At environmental temperatures below the threshold of scale development (2 and 8°C), invertase activity was decreased about 30%. At higher temperatures such as 32°C, the Florida red scale invertase was found to be physiologically better adapted than that of the California red scale.

Trehalase, another carbohydrase which in insects degrades trehalose to glucose for internal energy supply, was assayed along with invertase and amylase for assessing the adaptability of the black scale, Saissetia oleae, to various host plants. Trehalase activity in scales reared on potato sprouts was about 3.5- and 4-fold greater than that in scales reared on oleander and citrus plants, respectively. The enzyme activity correlated well with the scale generation time; thus, the duration was shorter on potato sprouts vs oleander and citrus plants. Invertase activity, however, was affected to a lesser extent that that of trehalase. These results suggest that trehalase and to some extent invertase could be used as parameters to assess the adaptability of the black scale to its host plants.

In a study with the spirea aphid (Aphis citricola), the activity of the soluble trehalase (but not the membranous bound trehalase) was significantly higher in alates than in apterae. This enzyme may also be used as a parameter for assessing energetic processes important in the flight of aphids.

7S-1,5 FEEDING BEHAVIOR OF THE GREEN RICE LEAFHOPPER (NEPHOTETTIX CINCTICEPS) ON RESISTANT AND SUSCEPTIBLE RICE PLANTS AND CAUSATIVE FACTOR OF THE RESISTANCE.

Kawabe, S.(Tohoku Nat. Agr. Expt. Stn., Omagari, Akita, 014-01 Japan)

Many indica rice varieties are resistant to the green rice leafhopper, which is one of the most injurious rice plant pests in Japan.

Feeding behavior of the leafhopper on resistant and susceptible plants was investigated by; 1) the analysis of excretory droplets, 2) the electronic measurement of feeding behavior, and 3) the histological methods. The leafhopper scarcely ingested sap from phloem sieve elements but more from xylem vessel on resistant plants, while it did from both phloem and xylem on susceptible plants. Because the leafhopper easily inserted the stylet into sieve elements but withdrew it after several minutes, it was surmised that the sieve elements of resistant plants contained a feeding deterrent. In order to search for the deterrent the phloem saps of resistant and susceptible plants are being collected through the stylets embedded in sieve elements and severed by a YAG laser.

It is remarkable that antibiosis, antixenosis and tolerance are all present in the resistant plants. These three components of the resistance are discussed in relation to the feeding behavior.

7S-1,6 PHENOTYPIC INTERACTIONS BETWEEN SPOTTED ALFALFA APHID BIOTYPES AND RESISTANT ALFALFAS.

Nielson, M. W. (USDA, SEA-AR, Tucson, Arizona)

Response of alfalfa genotypes to biotypes of the spotted alfalfa aphid, Therioaphis maculata (Buckton) varied according to the genotypes for resistance in the plant and the genotypes for virulence in the insect.

Phenotypic expression for resistance in the 9-clone alfalfa cultivar Moapa to 4 biotypes was as follows: 9 clones resistant to biotype B, 6 to A, 4 to F and 2 to H. However, phenotypic expression for resistance in the 5-clone alfalfa cultivar Lahontan was identical to all biotypes, i.e., 3 clones were resistant and 2 were susceptible to biotypes B, A, F and H. The biotypes were discovered and identified chronologically between 1954 and 1974.

These data suggest that 2 different genic systems controlled the expression of phenotypic interactions between resistance in alfalfa genotypes and virulence in spotted alfalfa aphid biotypes.

7S-1,7

EFFECTS OF APHID FEEDING ON ASSIMILATION AND PRODUCTIVITY OF PEA PLANTS. Barlow, C.A. (Dept. Biol., Carleton Univ., Ottawa K1S 5B6, Canada)

Infestations of 5 to 50 aphids/plant resulted in losses of 8.2% to 112.8% of net primary productivity of young pea plants over 11 days. The highest rate of energy extraction by aphids that was sustained by pea plants without loss of NPP was ca. 3.5 cal/plant-day. Extraction of ca. 32.7 cal/plant-day completely eliminated pea NPP. Aphid feeding affected production of peas by removing the amount actually ingested and because of lost production that would have resulted from the consumed material. The proportion of photosynthetic tissue was not reduced by heavy aphid infestation, but both the net relative growth-rate and net assimilation-rate or production efficiency of the plants were reduced.

7S-1,8

INJURY CAUSED BY LYGUS RUGULIPENNIS POPP. TO ITS HOST PLANTS. Varis, A.-L. and Laurema, S. (Dept. Agric. Forest Zool., Univ. Helsinki, Finland)

Lygus rugulipennis occurs on different crops in Finland. Its feeding may be harmful to the hosts especially when the plants are young. When present on sugar beet seedlings, for example, it causes local lesions, wilting, malformation and retarded growth (Varis 1972). As these injuries can be simulated with mechanical damage and pectinase, further investigations were made on salivary pectinase. Strong pectinase activity was detected in the salivary glands of L. rugulipennis. This activity was higher at pH 5 than at pH 4, 6, 7 and 8, and also considerably higher at 37°C than at 15°C. The activity of the enzyme was inhibited by cations Fe^{3+} and Ca^{2+} (pH 5, 37°C). Mg^{2+} was also inhibitory at high concentrations, while K^{+} and Na^{+} were activators. The pectinase activity was greater in new adults than in hibernated adults and also greater in females than in males. The activities of amylase and protease in the salivary glands of L. rugulipennis were also estimated. Salivary gland extracts tested at three different concentrations were not found to have any effect on the growth of Avena coleoptile.

7S-2,9

INSECT OCTOPAMINERGIC NEURONS. Hoyle, G. (Dept. Biol., Univ. Oregon, Eugene, OR. 97403)

Clusters of up to 24 nerve cell bodies are found in the mid-line (M) on the dorsal (D) surface of the thoracic and abdominal ganglia of many insects including all known Orthoptera. Of these, several are of unique unpaired (U) neurons that make a T branch providing symmetrical left and right axons. Branches from the axons enter neuropile of motor neurons. In addition, the axons of some of these DUM neurons continue into motor nerves. In Schistocerca gregaria the axons of two of the DUM neurons of the third thoracic ganglion were traced all the way to their terminals, which were in the extensor tibiae muscle for one (DUMETi) and the dorsal longitudinal flight muscle for the other (DUMDL). Characteristic large dense core vesicles, with a crystalline structure, occur in the soma, along the axon and in the terminals. Indirect and also direct tests have established that those DUM neurons that innervate muscles synthesize and release octopamine which acts non-synaptically as a modulator of transmission and a biochemical activator. DUM neuron somata are electrically excitable, with large overshoots and the very large undershoots characteristic of neurosecretory neurons, that restrict discharge frequency to a few Hz. They are excited by all modalities of sensory input, discharging in bursts that precede motor output in both reflex and voluntary motor activity. The neuromuscular action of octopamine is primarily on slow motor neuron transmission, which is at first briefly facilitated but then depressed markedly. Quick movements occurring sporadically are enhanced, but tonic postural contractions are reduced, as is intrinsic rhythmicity, which is abolished. Octopamine does not promote one class of postures, as has been found in crayfish. After injection of a high dose of octopamine the insect is depressed and inactive and may have some altered reflex actions, but low doses may be stimulatory. The DUM neurons may be classed as modulatory, but their full functional significance is not yet understood. Supported by BNS 79-23786 National Science Foundation

7S-2,10 DISCRIMINATION OF SIGNALS FROM NOISE IN THE ESCAPE BEHAVIOR OF COCKROACHES. Camhi Jeffrey M. and Plummer, Mark. (Sect. of Neurobiol. & Behav., Cornell Univ., Ithaca, NY 14850 USA)

The cockroach Periplaneta americana responds to gentle wind puffs by turning and running away from the wind source. It detects and escapes from the strike of a natural predator, the toad Bufo marinus, by sensing primarily or only the minute wind which the toad makes during its strike. How is this signal (toad's wind) discriminated from noise (background wind)?

Cercal wind receptors are subject to a large and complex wind field. In addition to ambient winds (room currents up to 50 mm/sec in our lab), freely walking cockroaches generate a "relative wind" directed posteriorly whose speed equals the forward walking speed (at slow walking, 3 steps/sec, relative wind = ∿ 80 mm/sec). Also, wind gusts of 1-30 mm/sec are produced by every walking step of a leg. The sum of these winds constitutes a background noise about 25 times greater than the just-threshold signal (in a slowly walking animal, mean threshold for a pause or startle response, 3 mm/sec; for a running response, 12 mm/sec).

The cockroach appears to discriminate signals from noise by means of a built-in wind accelerometer in the escape circuit. We found the acceleration of the threshold wind puff was greater than that of noise (noise, 0-300 mm/sec^2; threshold for pause, 300 mm/sec^2; for running, 750 mm/sec^2). Using ramp stimuli of 40 mm/sec peak flow rate but variable acceleration, accelerations greater than about 750 mm/sec^2 consistently evoked running, 300-750 mm/sec^2 evoked a pause in walking, while accelerations below 300 mm/sec^2 usually elicited no response. Recordings were made during walking from the giant interneurons that mediate the escape behavior. For wind puffs of constant peak velocity but variable acceleration, the greater the acceleration the greater the response. Thus these cells encode wind acceleration.

7S-2,11 A MECHANISM FOR GENERATING A LONG LASTING FIXED ACTION PATTERN. Truman, J.W. (Dept. Zoology, Univ. Washington, Seattle, WA 98195 U.S.A.

In the moth, Hyalophora cecropia, a peptide hormone, the eclosion hormone, acts to release a sequence of 3 stereotyped behaviors that last over 3 hours. Experiments with isolated CNS preparations indicated that at least the first 2 behaviors in the sequence -- the pre-eclosion and eclosion behaviors -- are prepatterned into the CNS and can be generated in their proper order after only a brief, 5 to 10 minute, exposure to the peptide in the bathing medium.

The neural response to this peptide signal appears to be mediated through changes in cyclicGMP levels. This cyclic nucleotide effectively mimics the action of the eclosion hormone when administered in vivo or to the isolated CNS. Also, exposure of the CNS to the peptide results in a cyclicGMP increase that precedes the first neural response. Lastly, the behavioral response of the insect to the eclosion hormone is closely correlated with the cyclicGMP response of the nervous system. A model will be presented which explores the role of cyclicGMP in not only the triggering of the behaviors but also in determining their sequential arrangement.

7S-2,12 REORGANIZATION OF THE MOTH NERVOUS SYSTEM DURING METAMORPHOSIS. Levine,R.B.and Truman,J.W. (Dept. Zool.,Univ. Wash. Seattle,WA. 98195 U.S.A.)

During metamorphosis the holometabolous insects undergo significant changes in morphology and behavior. The nervous systems of these insects must adapt accordingly. In an investigation of this process we have focused on the motor neurons innervating the abdominal musculature of Manduca sexta. The intersegmental muscles of the abdomen are of embryonic origen and persist throughout larval, pupal, and early adult stages. They are innervated by the same excitatory motor neurons at all stages. The basic dendritic morphology of these neurons changes very little during metamorphosis, although there is a slight increase in the extent of dendritic branching. Other larval muscles degenerate at the onset of pupation. Of the motor neurons which innervate them, some degenerate during the pupal stage, while others are maintained and later innervate newly-generated adult muscles. The dendrites of motor neurons in the latter group undergo significant structural reorganization during pupation. The motor neurons, including those which undergo dendritic reorganization, continue to be electrically excitable and to receive synaptic inputs throughout metamorphosis. Some inputs are maintained throughout post-embryonic life. One is from abdominal stretch receptors. These sensory neurons excite ipsilateral motor neurons monosynaptically, and inhibit contralateral motor neurons through a polysynaptic pathway. Other sources of innervation are present for only part of the insect's life in accordance with the different behaviors in which the motor neurons participate at different stages. An example is the excitation derived by the intersegmental motor neurons from sensory hairs embedded in the cuticular "gin traps". This polysynaptic pathway mediates a pupal-specific defensive behavior(Bate,1973). Thus while much of the abdominal nervous system is conserved during metamorphosis, new elements are added to the basic framework.

7S-2,13 CENTRAL EFFECTS OF ECDYSTERONE CONTROLLING WANDERING BEHAVIOR IN THE CATERPILLAR, MANDUCA SEXTA. Dominick, O.S. and J.W. Truman. (Dept. of Zoology, Univ. of Washington, Seattle, WA 98195, USA)

The prepupal wandering behavior of last (5th) instar larvae of the tobacco hornworm, Manduca sexta, is induced by a pulse of the steroid molting hormone, ecdysterone. Infusion of ecdysterone into intact larvae controls both initiation time and duration of the behavior in a dose dependent manner, and requires a latency of 10-20 hours as is typical of steroid hormone action. The ecdysterone induced effects include changes in neural function of a number of different parts of the larval CNS. In addition, all earlier instars which we have been able to test (2nd, 3rd, and 4th instars) can produce the wandering behavior in response to the appropriate ecdysone signal.

We can investigate ecdysterone induced changes of neural function directly by long term (24 hour) studies of the isolated (entire) CNS of Manduca larvae. Extracellular recordings are obtained from a compound nerve whose role in locomotion is known, Such recordings from the CNS isolated from larvae prior to ecdysterone release show consistently low levels of spontaneous, strongly phasic bursting (8.8 ± 3.8 bursts/15 min.), while the spontaneous activity of the CNS from wandering animals is much greater (42.9 ± 13.6 bursts/15 min.). Several independent lines of evidence indicate that these bursts represent locomotor activity symptomatic of wandering: anteriorly directed phasing between ganglia is preserved, and recordings from chronic preparations of whole larvae demonstrate that bursts from this nerve occur only in conjunction with observeable locomotor events.

The active bursting state characteristic of the isolated wandering CNS can be induced in vitro in "quiet" pre-ecdysterone nerve cords by prolonged incubation in ecdysterone (10-15 hours in 1 μg/ml solution). Therefore, we feel that the behavioral action of this steroid is directly on the larval CNS. Several of the motoneurons which participate in the behavior, as well as the synaptic inputs to them, have been identified, and we are studying these as possible sites of hormonally altered neural function.

7S-3,14 CHEMICALS INVOLVED IN HOST SELECTION BY ONION FLY LARVAE, HYLEMYA ANTIQUA (DIPTERA, ANTHOMYIIDAE). Ishikawa, Y., T. Ikeshoji and Y. Matsumoto (Dept. Agr. Biol., Univ. of Tokyo, Tokyo 113 Japan)

Organic sulfur compounds and ethyl acetate emanating from larvae-infested onions are known to attract onion fly larvae. However, this olfactory factor alone is not enough to explain the high specificity of onion-onion fly relationship. Initial attack of onion fly larvae is concentrated to the root-stem part of onion and they eat into onion from this part. This behavior of larvae suggests the existence of a strong phago-stimulant(s) in this part of onion. The agar disk containing MeOH extract of whole onion showed both strong arrestancy and phago-stimulancy against onion fly larvae, while this extract failed to show any attractancy. Bioassay on the extracts of the root-stem part and the rest part of onions revealed that the phago-stimulant is more than 10 times abundant in the former compared with the latter. The threshold concentrations stimulating their feeding were 3.3 mg of the root-stem extract per cm^3 agar and 36.8 mg of the rest part extract. This differential concentrations of phago-stimulant between those onion tissues may explain the feeding behavior of the larvae. The mode of the host-plant selection by onion fly larvae is discussed in regard to these chemicals and their sensory organs.

7S-3,15 THE ROLE OF VOLATILE CHEMICALS IN HOST SELECTION BY THE ONION MAGGOT, HYLEMYA ANTIQUA (MEIGEN) (DIPTERA:ANTHOMYIIDAE). Borden, J. H. (Pestology Cent., Dept. Bio-Sci., Simon Fraser Univ., Burnaby, B.C., Canada, V5A 1S6)

A bioassay in which female Hylemya antiqua oviposit through small apertures in response to volatile stimulants facilitated the identification from Porapak Q-trapped onion volatiles of three new oviposition stimulants: methyl propyl disulfide, cis- and trans-propenyl propyl disulfide. Based on similarities between these and two known stimulants, propanethiol and dipropyl disulfide, a hypothesis was proposed (coincidentally with Japanese researchers) that a common thiopropyl group was responsible for olfactory receptor stimulation. Experiments revealed the essentiality of a single sulfur atom with two unshared electron pairs, bonded to a saturated hydrocarbon chain 3-5 carbons long. Associated groups compatible with the active structure ranged from a single hydrogen to saturated and unsaturated hydrocarbon chains 1-5 carbons long. Incompatible moieties nullifying oviposition were observed in propyl thiocyanate, dipropyl sulfoxide and propionaldehyde dipropylthioacetal. Nine new oviposition stimulants were identified on the basis of these experiments. Of 13 oviposition stimulants tested as attractants in the field, dipropyl disulfide, propanethiol, dipropyl sulfide, propenyl propyl sulfide, 2-butyl propyl sulfide, dibutyl disulfide and methyl butyl disulfide were attractive, mainly to males. Females were more responsive than males to onion odor. Four onion-produced aldehydes, propionaldehyde, 2-methyl butanal, 2-methyl pentanal and trans-2-methyl-2-pentanal, were attractive to females, whereas a mixture of aldehydes and thiopropyl-containing compounds was attractive to both sexes.

7S-3,16

Gerald A. Rosenthal, University of Kentucky, Lexington, Kentucky 40506 USA

Biochemical Interactions between the canavanine-containing legume, Dioclea megacarpa and its seed predator, Caryedes brasiliensis.

The neotropical legume, Dioclea megacarpa is unusual in that the non-protein amino acid, L-canavanine accounts for some 13% of the dry matter of the seed. This secondary plant metabolite is a potent arginine antagonist which exhibits appreciable antimetabolic properties. Developing larvae of the bruchid beetle, Caryedes brasiliensis are unique in their ability to utilize this toxic seed as a food source. It is able to consume and utilize this poisonous plant material as a result of a series of biochemical adaptations to this toxic plant compound and its metabolic derivatives. The biochemical nature of these adaptations in the context of insect-plant coevolution will be considered.

7S-3,17

INSECT GROWTH INHIBITORS IN CROP PLANTS. Waiss, A. C. Jr., Chan, B. G., Elliger, C. A., Dreyer, D. C., and Binder, R. G. (WRRC, USDA, SEA, AR, Berkeley, California 94710, U.S.A.)

Diverse classes of organic compounds showing growth-inhibitory activity toward Lepidopterous larvae have been isolated from sunflower, cotton, corn and soybean plants. These compounds include diterpenoid acids, cyclopropenoid acids, flavonoids and cyclitols. The structure of these compounds, their biological activities and their role in the plant's defense against insects will be discussed.

7S-3,18

FACTS AND GENERALITIES IN INSECT/HOST-PLANT RELATIONS

Bernays, E.A. (COPR, London)

An outline is given of different approaches to the study of insect/host-plant relationships. Attention is drawn to the value and to the limitations of ever more detailed studies, and of all-embracing theories which have resulted from the currently intensive search for patterns in ecosystems and parallels in physiological mechanisms. New work on phenolic compounds from plants and the significance of these compounds in the lives of acridids is presented to illustrate some of the arguments.

7S-4,19 SENSORY PHYSIOLOGY AND INSECT BEHAVIOUR.

Den Otter, C.J. (Dept. of Zoology, Groningen State University, Postbus 14, 9750 AA HAREN, The Netherlands)

Olfaction plays a prominent role in sexual communication and food plant choice in insects. Both field and laboratory bioassays have shown that for the release of the successive steps of sexual behaviour different concentrations and/or different components of the sex pheromone are needed. Sexual preference may be augmented by odours from the host plants or weakened by those from non-hosts. This is discussed in relation to olfactory receptor electrophysiology, which offers a valuable means for interpreting and predicting the behavioural responses to chemical stimuli.

7S-4,20 SEX ATTRACTION IN LEPIDOPTERA: DEFINITION OF THE SENSORY INPUTS AND BEHAVIORAL RESPONSES.

R. T. Carde, Dept. of Entomology, Pest. Res. Ctr., Mich. St. Univ., E. Lansing, MI 48824 USA.

Understanding the orientation and recognition mechanisms involved in mate location in moths requires elucidation of the complete pheromone message, its rate of entrainment into the atmosphere and the process of its dispersal in a wind field. Upwind anemotaxis, landing and recognition of the female by the male appear to be under guidance of visual, tactile, as well as chemical, sensory inputs.

7S-4,21 PHEROMONAL CONTROL OF MATE SEARCHING BEHAVIOUR IN LEPIDOPTERA.

Kazuo Nakamura (Div. Ent., Ntl. Inst. Agr. Sci., Yatabe, Ibaraki, 305 Japan)

Mate searching behaviour of male moths begin, in general, with take-off from their living places and is followed by random flight for searching their mates. Perceiving a certain concentration of female sex pheromone, males orient towards the pheromone source (a female) and approach to it.

Our works on the mate searching behaviour of Spodoptera and Adoxophyes have revealed that major and minnor components of their sex pheromones have different functions each other on steps in these searching processes. On the otherhands, it has been shown that in some species male moths orient towards their host plants (or fly randomly around the habitat where females live) and then, approach to females. Differences in the pattern of the mate searching process and in the factors effecting these behaviours in each species would have a connection to the difference in their living habitats and the life-forms of species. Elucidation of the process of these behaviour and the determining factors is basically important for the application of pheromones to insect pest control through trap-out and communication disruption.

7S-4,22 PHEROMONAL AND OTHER OLFACTORY INFLUENCES ON HOST COLONIZATION BY PINE BARK BEETLES.

Birch,M.C. (Dept.Ent.,Univ.California,Davis,CA95616,USA)

A complex system of chemical communication has evolved around the arrival and colonization by pine bark beetles of their host trees. Some of the results of this web of chemically-mediated behavioral interactions are that: (1) beetles arrive at trees in sufficient numbers and in a short enough time period to kill a tree and obtain a breeding site, (2) components of their pheromones, or other chemicals, deter competing species from the site, (3) predators and parasites of the attacking species are attracted during colonization, (4) after colonization, many other organisms arrive. (Auditory and visually-mediated behaviors are also involved). This system will be described using examples primarily from bark beetles inhabiting ponderosa pine in California. The potential for exploiting different parts of this system in pest management will be evaluated.

7S-4,23 ALARM AND TRAIL PHEROMONES IN SOCIAL INSECTS.

Blum, M. S. (Dept. of Entomology, Univ. of Georgia, Athens, Georgia, 30602, USA)

Alarm and trail pheromones have been demonstrated to be characteristic of species of ants, bees, wasps, and termites. The parsimonious utilization of these pheromones will be analyzed as a highly adaptive means of exploiting sociality. Apparent evolutionary trends in trail-following behavior will be examined for a variety of eusocial species that exhibit idiosyncratic means of generating trails. The anatomical sources and chemistry of both alarm and trail pheromones will be explored as a function of the evolution of these volatile information-bearing stimuli in social insects.

7S-5,24 APPLICATION OF COMMUNICATION DISRUPTION TO PECTINOPHORA GOSSYPIELLA.

Brooks, T.W., Doane, C.C. and Haworth, J.K. (Conrel, An Albany International Company, 110 A St., Needham Hgts., Massachusetts 02194 U.S.A.)

Suppression of Pectinophora gossypiella population growth in cotton can be accomplished by timely application of sex pheromone (a 1:1 mixture of Z,Z and Z,E-7,11-hexadecadienyl acetates) formulated in a hollow fiber controlled release medium designed for broadcast dissemination. This application of the pheromone communication disruption concept has been reduced to commercial practice on a worldwide basis under a variety of climatic and cultural conditions. Suppression of P. gossypiella by the pheromone communication disruption method substantially reduces the amount of insecticide necessary to protect cotton crops and in some cases has afforded enhanced yields of fiber. Fiber and seed quality improvements have also been observed in cotton insect pest management schemes involving P. gossypiella suppression with pheromone as a key element. Considerable evidence is now available to indicate that P. gossypiella communication disruption is a practical, economical, and ecologically sound alternative to control methods based largely on toxic chemicals.

7S-5,25 LEPIDOPTERAN SEX PHEROMONES AND PEST MANAGEMENT IN DEVELOPING COUNTRIES.

Campion, D.G. (Centre for Overseas Pest Research, London W8, UK.)

Strategies for the use of pheromones for the control of insect pests have generally been developed in countries of advanced technologies. In this paper the relevance of pheromones to the needs of agriculture in developing countries are discussed with particular reference to work by Scientific Units of the UK Overseas Development Administration.

7S-5,26 THE USE OF SEX PHEROMONES IN JAPAN.

Wakamura, S. (Shikoku Agric. Exp. Station, Zentsuji, Kagawa, 765 JAPAN)

Japanese agricultural entomologists have researched on the use of synthetic sex pheromone as a tool of insect pest control in three ways, mass-trapping method, communication disruption method, and application to forecasting. Mass trapping of male moths have experimentally succeeded in several insect pests, such as *Glapholitha moresta* and *Adoxophyes* sp. (the smaller tea tortrix), and it is on research in *Spodoptera litura* and *Adoxophyes orana fasciata*. Injury patterns by *G. molesta* was revealed to be possible to estimate from the interpretation of the patterns of catches with sex pheromone trap and temperature-dependent development data of this species. The possibility of forecasting the injury level by *S. litura* was revealed from life-table research combined with that on catches with sex pheromone trap. I will introduce some examples of the use of sex pheromone in Japan, and will discuss on the possibility of practical use of pheromones in future.

7S-5,27 MASS TRAPPING TO REDUCE WESTERN PINE BEETLE-CAUSED TREE MORTALITY IN A PEST MANAGEMENT CONTEXT-A CASE HISTORY.

Bedard, W. D. and Wood, D. L. (Pacific SW Forest & Range Exp. Sta., Forest Service, U.S. Dept. of Agr., Berkeley, CA 94701)

In a program to develop mass trapping as a suppression tactic in the management of *D. brevicomis*, the following has been accomplished. The origin of the aggregative stimulus was found and a potent attractant was identified. Variables related to attractive trap design were evaluated so that catch could be increased and the tendency for trees near traps to be attacked was decreased. On the basis of these results, an efficient, durable, inexpensive, and easily deployed trap was designed. Means were developed to mass produce the attractant and release it at known rates while maintaining its integrity. Beetle caused-tree mortality was reduced and redistributed during a large scale trial to suppress *D. brevicomis* by mass trapping. Future effort will be directed toward demonstrating crop protection and developing the pest management system to insure that this tactic is environmentally acceptable and economically efficient.

7S-5,28

DISRUPTION OF PHEROMONE COMMUNICATION CONTROLS DAMAGE CAUSED BY WESTERN PINE SHOOT BORER.

Daterman, G. (U.S. Forest Service, Pacific NW Forest Exper. Sta., Corvallis, Oregon, USA 97331)

In Western North America larval feeding of the western pine shoot borer, *Eucosma sonomana* Kearfott, stunts and occasionally kills the leader shoots of young pines, causing reduced height growth and deformed stems. A single larva per tree, boring in the pith of the terminal shoot, can cause significant damage. Even in heavy infestations, total adult numbers are not likely to exceed several hundred insects per hectare. Because of its characteristic low population densities, *E. sonomana* was considered an excellent candidate for control by mating disruption.

Development of mating disruption for *E. sonomana* has proceeded with both aerial and ground methods of application. Two pheromone formulations with aerial distribution capability were evaluated. These were the ConRel hollow fiber and Hercon flake formulations, both of which are commercially available. For ground application, smaller plots were gridded with strips of solid polyvinyl chloride plastic containing the synthetic attractant. All three formulations and both aerial and ground techniques were successful. Behavioral responses of males were almost totally disrupted, and damage to terminal shoots was reduced 67 to 88 percent. Aerial application of the Hercon and ConRel formulations appears effective for operational treatment of large plantings, whereas the ground application system is considered more practical for smaller, accessible plantations. Treatments appear highly specific for *E. sonomana*, and no adverse environmental effects are known.

7S-5,29

APPLICATION OF PHEROMONES TO PEST MANAGEMENT OF STORED PRODUCT INSECTS.

Burkholder, W. (USDA, Dept. of Ent., Univ. of Wisconsin, Madison, WI 53706 USA)

Pheromones have been used to monitor populations of several species of stored product insects in warehouses and food processing facilities. Data concerning the presence, location, density and kind of insect pest can be utilized to plan corrective measures including removal of the infested commodity or pesticidal treatment. Traps have been used in US port facilities for detection of the quarantined khapra beetle, *Trogoderma granarium*. In other *Trogoderma* trapping studies the distribution and location of traps within a warehouse have been evaluated. Floor placed traps were generally superior to aerial traps. Male response was directly proportional to increase in temperature. *Trogoderma* pheromones were combined with a protozoan pathogen, *Mattesia trogodermae*, in inoculation devices to successfully disseminate the pathogen within a population of insects. Megatomoic acid, the pheromone of the black carpet beetle, *Attagenus megatoma*, has been used in warehouses to monitor the seasonal emergence of the insect or to disrupt mating. The population aggregating pheromone of the lesser grain borer, *Rhyzopertha dominica*, has been used to monitor populations of the insect in a variety of warehouses. Trapping out of a population is more promising with this species since both sexes are attracted. Pheromones are now available for a variety of dermestid beetles; the lesser grain borer; the drugstore beetle, *Stegobium paniceum*: the cigarette beetle, *Lasioderma serricorne*; the angoumois grain moth, *Sitotroga cerealella*; the Indian meal moth, *Plodia interpunctella* and several other pyralid moths.

7S-6,30

CHEMICAL STRUCTURE OF INSECT SEX PHEROMONES; SOME RECENT DEVELOPMENTS.

A. S. Hill and W. L. Roelofs (Dept. Ent., NY State Agric. Expt. Station, Geneva, NY. USA 14456)

The structures of some sex pheromones recently identified at our laboratories will be presented. Some possible inter-relationships between insect sex pheromone structures and taxonomic groupings will be discussed.

7S-6,31 EFFECTS OF PHEROMONE CONCENTRATION ON ORIENTATION MOVEMENTS OF FLYING AND WALKING MOTHS.

Baker, T.C. (Dept. Ent., University of California, Riverside, USA)

Orientation movements of male Oriental fruit moths, Grapholitha molesta (Busck) were studied in pheromone-permeated airstreams. Velocity of movement decreased and rate of turning increased at higher concentrations, resulting in arrestment of progress toward the pheromone source. Arrestment occurred close to the source at lower emission rates and farther away at higher rates. Attraction and arrestment are parts of a continuum of velocity-to-turning ratios mediated by pheromone concentration.

7S-6,32 SEASONAL VARIATIONS IN THE PHEROMONE BIOLOGY OF PSEUDALETIA UNIPUNCTA AS A POSSIBLE EXPLANATION FOR SPORADIC EPIDEMICS IN EASTERN NORTH AMERICA.

McNeil, J., and Turgeon, J. (Dept. biol., Laval Univ., Quebec, Canada).

On emergence P. unipuncta females, from a laboratory culture reared at 25° and 16L8D photoperiod, were held at 10, 15, 20 or 25°C with a 16L8D photoperiod. As reported for other Lepidoptera the mean age at which females call for the first time increases with a decrease in temperature (4, 7, 11 and 18 days at 25, 20 15 and 10°C (respectively). However, contrary to information presently available in the literature we found that temperature conditions during pupal development also affect female calling behaviour. Eggs and larvae were reared at, and females tested at 25°C while pupal were held at either 15, 20 or 25°C. Females reared at lower pupal temperatures (i) commence calling later (4, 4.6 and 6.7 days for pupal temperatures of 25, 20 and 15°C), (ii) have a mean onset calling time, that is delayed for up to 75 minutes, and (iii) spend less time calling per night, by as much as 45 minutes. These results indicate that soil, as well as air temperatures will have an impact on calling behaviour, subsequent mating success and consequently on the density of overwintering populations. This idea is supported by the incidence of mating observed in second generation females caught in light traps at Normandin, Quebec in 1977, 1978 and 1979. Less than 0.4% females were mated in 1977 and 1979, while more than 5% were mated in 1978 with a wide spread epidemic being observed in the spring of 1979. The effect of different plant hosts on the rate of development of this polyphagous insect will also be considered as it could affect the time (and thus the temperature conditions) at which pupation and adult emergence occur during the second generation of P. unipuncta. The use of pheromone traps in a management programme will be discussed in light of these results.

7S-6,33 THE RÔLE OF DISPARLURE IN GYPSY MOTH MANAGEMENT.

Cameron, E.A. (Dept.Ent., Penn State Univ., University Park PA 16802 USA)

Disparlure (cis-7,8-epoxy-2-methyloctadecane), the synthetic pheromone of the gypsy moth, Lymantria dispar (L.) (Lepidoptera: Lymantriidae), is widely and successfully used - especially as the (+)-enantiomer - as an attractant in traps employed in programs for survey and detection, to map the distribution of this insect, and to monitor its expanding range in North America. It is used increasingly to delimit the boundaries of localized infestations in previously uninfested areas. Disparlure-baited traps, or various formulations for broadcast applications designed to disrupt adult chemical communication, have been much less successful and promising for population reduction or "management". Numerous reports exist of reduction in numbers of males captured in baited traps which have been deployed in treated areas to measure "disruption", and of reduction in the proportion of mated females in treated areas compared with untreated check areas; however, convincing demonstrations of reduction of field populations in the next generation are unavailable. Whether continuing improvements in controlled release formulations of disparlure will alter this situation remains to be demonstrated. Simultaneously we require a better understanding of adult behavior, and especially of how this is mediated by the pheromone.

There may be a rôle for racemic disparlure, most likely in combination with pesticides, when the program objective is to eliminate a newly discovered incipient infestation which is restricted in area and isolated from other infestations. Cost of the pheromone, its formulation and application, as well as efficacy demonstrated to date, mitigate against its extensive use in other kinds of management programs.

7S-6,34

The smaller tea tortrix mass trapping in Japan.

Negishi Tsutomu (lab.Agr. Chm.Res.,Otsuka Pharmaceutical Co.Ltd.,Tokushima Japan)

Mass-trapping of the smaller tea tortrix,*Adoxophyes* sp., with sex attractant[(Z)-9-TDA:(Z)-11-TDA:(Z)9,(E)12-TDDA: 11-methyl-(Z)9,12-tridecadienyl acetate=7:3:3:0.2] was tested in tea plant fields(24 traps /500 m^2 at Shizuoka, 35 traps/750 m^2 at Kumamoto in 1978, 248 traps/5000 m^2 at Mie, 478 traps/10000 m^2 at Kumamoto in 1979). Sticky traps(1C trap) were deployed generally 4-5 m apart. Attractant despensers were renewed at the start of each flight season. Total moth catch at Shizuoka, Kumamoto in 1978, Mie and Kumamoto in 1979 during 1 st flight was 4000, 2000, 24000 and 18000 respectively and 1100,3000,10500 and 8700 during 2nd flight. Larval damage in mass trappped fields after 1st flight for the corresponding fields was 3.4, 4.4, 16.0 and 1.8/m^2 and that after 2nd flight was 0.2, 4.6, 8.3 and 4.5 respectively. The conventional controlled fields had 6.6, 8.7, 34.7 and 6.2 larval damage after 1st flight at Shizuoka Kumamoto in 1978, Mie and Kumamoto in 1979, respectively and had 0.7, 7.8, 46.3 and 20.0 after 2nd flight. Leaf damage from these trials in the unsprayed tea fields suggested that mass trappping of the smaller tea tortrix with sex attractant traps was as effective as or more than a insecticides applications in reducing damage.

7S-6,35

PHEROMONAL CONTROL OF DENDROCTONUS FRONTALIS AND ITS APPLICATION TO PEST MANAGEMENT.

Payne, T. L. (Dept. Ent., Texas A&M University, College Station, TX 77843, USA)

Several behavioral chemicals, including attractants and inhibitors, have been found to play a role in the landing and attack behavior of the southern pine beetle, *Dendroctonus frontalis* Zimmerman (Coleoptera: Scolytidae). Pest populations of *Dendroctonus frontalis* have been successfully manipulated with both attractants and inhibitors. The attractant mixture frontalure was used effectively to disrupt and subsequently halt the growth of active beetle infestations when placed as a bait on selected host and non-host trees within infestations. The attractant effectively redistributed the population of attacking beetles and prevented the attack of new host trees.

The inhibitors *endo*-brevicomin and verbenone were used effectively to reduce landing and attack by *Dendroctonus frontalis* on treated trees and in areas where the inhibitors were released in an area permeation. The compounds did not prevent trees from succumbing to beetle attack initially. However, the infestations did halt. It is hypothesized that the reduction of beetle attack and, subsequently, brood production resulted in the eventual collapse of the infestations.

7S-6,36

PRESENT STATUS OF INSECT PHEROMONE RESEARCHES IN CHINA.

Chen, T.M. (Dept. Biol., Beijing Univ., Beijing, China)

Although the earliest investigation on insect pheromone in China had already been started in 1964, but due to the interruption of the Cultural Revolution only until 1973 researches in this field have then been resumed. China has a rather short history in the field of insect pheromone research, yet some progresses have been made during the period of recent seven years in several aspects including the morphological studies of pheromone secretory glands, the isolation, identification and synthesis of insect sex pheromones, the behavior responses to these behavior-controlling chemicals as well as their applications in pest management. In this article, recent advances in the research works on the kairomone and trail pheromone will also be summarized.

7S-6,43

MECHANISMS OF COMMUNICATION DISRUPTION BY PHEROMONES. BARTELL, R.J. (CSIRO, DIV.ENT, CANBERRA,AUSTRALIA)

Four possible mechanisms of the disruption of mating communication are presented. Although they are somewhat interrelated, these include -

1. Direct neurophysiological effects involving adaption of pheromone receptors and central nervous habituation brought about by relatively constant, high levels of exposure to pheromone.

2. 'Confusion' of responding insects presented with a multiplicity of 'false' trails which divert them from calling females.

3. Impairment of the discriminatory powers of responding insects to distinguish between individual odour trails from calling females and a general odour background.

4. Imbalance in the pattern of sensory input when the ratios between chemical components of naturally occurring pheromone trails are distorted by the relatively massive 'control' liberation of a single component.

Some experimental evidence in examination of these possible mechanisms is given.

7S-7,37

Processing of biologically relevant sounds within the nervous system of Orthopterans Kalmring, K. (Dept. Zool., Marburg Univ., West-Germany)

Coding in the auditory system of Orthopterans is far more comprehensive than would be required for detection and recognition of the conspecific song. The information the receptors provide about sound signals from the enviroment is preserved as a basis for subsequent processing. Such processing of the signals from the ventral-cord neurons enables recognition and localization of a stridulating animal of the same species.Moreover, other noises in the animals surroundings can be detected and analyzed, a function in some cases crucial to survival.
The acoustic ventral-cord neurons are at least bisensory information carriers. Their inputs come not only from the receptor cells of the two tympanal organs, but also from those of the vibration receptors on all six legs. Identical dendritic regions receive both tympanal auditory information and sensory signals from the vibration receptors. But why does the animal use the same central neurons for information transmission in the auditory and vibratory senses? This may confuse the recognition of for example sound signals from the animals surrounding.However, in short distance communication the Orthopterans produce also vibratory signals,when they stridulate. Their vibratory signals reflect the time parameters of the song and have frequencies similar to itspulse rate.There are many ventral-cord neurons with enhanced and better synchronised responses to the syllables of the song,when stimulated with both kinds of stimuli:This"coprocessing" may help to make the song recognition clearer over short range distances and may also help to find the sound source easier.

7S-7,38

NEURAL CONTROL OF THE MATING DANCE IN BOMBYX MORI. Obara, Y. and Kondoh, Y. (Lab. Biol. Tokyo Univ. Agr. Tech., Fuchu, Tokyo, 183 Japan)

Male Bombyx mori responds to the female sex pheromone by displaying wing vibration, ambulation and occasional abdomen bending. These behaviors have been referred to as mating dance and been found to play an essential role as a sniffing behavior in the olfactory location of the female (Obara, 1979). Antennectomy, decapitation and the cervical nerve transection demonstrated the long lasting excitatory neural mechanism in the surpraesophageal ganglia which is activated by the sex pheromone and controls mating dance. Electrophysiological recordings revealed the descending interneurons in the cervical connectives which respond to the sex pheromone with a characteristic firing pattern. The interneurons maintained the high level of activities for a few minutes after being activated by the 1 sec pheromone stimulation. These are supposed to be closely associated with a command system of the mating dance. Nerve transection and electrical stimulation of the nerve trunks of the fourth abdominal ganglion revealed the nerve trunks along which the copulatory stimuli inhibiting wing vibration ascend.

Obara, Y. : Bombyx mori Mating Dance: an Essential in Locating the Female. Appl. Ent. Zool. 14 : 130-132 (1979).

7S-7,39 CENTRAL NERVOUS ORGANIZATION OF INSECT STRIDULATION.

Elsner, N., Otto, D. and Hedwig, B. (Dept. of Zoology, University of Göttingen, W.-Germany)

Orthopteran insects are known for their highly developed acoustic communication. Especially, the males display a rich variety of elaborate calling and courtship songs during pair formation. We are investigating this behaviour under broad neuroethological auspices including ontogenetic and evolutionary aspects. The goal of this research is to contribute to the understanding of the neuronal mechanisms underlying animal communication. Such an approach is confronted with a fundamental technical problem: Usually, a neurophysiological analysis requires a tethered animal, a situation which seems to impede any reliable behaviour. However, using brain lesion techniques (developed by F. Huber) long lasting sonorous stridulations can be released in tethered animals the central nervous system of which has been opened for microelectrode penetration. During artificially evoked stridulation we have recorded from multisegmental interneurons running in the neck-connectives. These neurons belong to a complex intersegmental stridulatory control system mediating song-specific information between the brain and the thoracic ganglia.

Our research has been supported by grants from the Deutsche Forschungsgemeinschaft.

7S-7,40 PERIPHERAL AND CENTRAL ASPECTS, OUTLINED FOR INSECT LOCOMOTION.

Wendler, G. (Zool. Inst., D-5 Köln 41, Weyertal 119)

Historically the generation of rhythmical motor patterns used in locomotion has been attributed either solely to the CNS or to sequences of peripheral reflexes. Studies of the locust flight system and the stick insect walking system have played an important role in the discussion of the alternatives.
Locust flight: On the basis of findings up until about 1970 the prevailing view was that the basic rhythm was centrally generated while the influence of peripheral sensory input served only to modify the motor output slowly over many wingbeats. This interpretation is here reevaluated on the basis of recent findings. It is shown that wing proprioceptors, such as stretch receptors and campaniform sensillae are constitutive parts of the pattern generator and furthermore that sensory inputs are sufficiently fast to affect the motor output from one wingbeat to the next. The stretch receptor, located in the wing hinge, was known to exert a slow excitatory influence on flight frequency. Recent studies reveal more rapid effects. When a sudden or gradual shift is superimposed on rhythmical up and down wing movements, the stretch receptor responds primarily by altering the phase of its response relative to the rhythmical movement. This phase shift provides a basis for rapid alteration of motor output. Stimulation of the campaniform sensilla on the ventral surface of the front wings results in fast contractions of ipsilateral and contralateral flight muscels. Stimulation at flight frequency evokes a co-ordinated muscle activity, similar to flight, although the animal is not flying. It is concluded that these proprioceptors must be regarded as part of the pattern generator in that they have rapid effects on the frequency and co-ordination of the motor output. Three aspects of the insect walking system will be discussed: 1.Properties of interneurons controlling speed and direction. 2.Phase coupling of the six legs. 3.Proprioceptive control of leg movements.

7S-7,41 PLASTICITY IN THE ESCAPE SYSTEM OF THE COCKROACH PERIPLANETA AMERICANA.

Camhi, J. (Section of Neurobiology and Behavior, Cornell Univ., Ithaca, NY 14850 USA)

Cockroaches respond to wind from the strike of a natural predator by turning away and running. This escape behavior is mediated by the sensory cells of wind-receptive hairs on the cerci. The sensory cells excite 7 bilateral pairs of giant interneurons (GI's) which contribute to evoking the escape behavior. We have studied the turning behavior and the GI responses to wind after covering or ablating one of the two cerci of late instar nymphs. In our behavioral tests, standard wind puffs were presented from different directions and the turning response were filmed. Then the left cercus was covered or ablated and the behavior was retested after one day and again after one month and longer periods. During this time, neither the ablated cercus nor any receptor hairs regenerated. Prior to cercal covering or ablation, all animals turned away from the source of wind stimulation. One day after covering or ablation most turns were to the left regardless of wind direction. By one month the animals had made a highly significant correction in their turning direction. Control experiments showed that covering the cercus did not kill the sensory cells but only eliminated their responses to wind. Thus long term unilateral silence or long term bilateral imbalance of wind receptor activity appears to determine how the cockroach evaluates sensory information from individual wind puffs.

To examine the cellular mechanisms of the behavioral correction, intracellular recordings were made from identified GI's before and after the period of correction in animals with unilateral cercal ablation. On day 1 after ablation, ipsilateral GI's 1, 2, 3 and 6 became nearly or totally unresponsive to wind. After the period of behavioral correction, each of these GI's showed an enhancement in its response to wind. The directionality of these cells was the same as in normal animals. This enhanced responsiveness of the GI's may underlie the observed correction of turning behavior.

7S-7,42

A neuroethological approach to learning in insects.

Menzel,R.(Inst.f.Tierphysiology,FB 23,WE 5, FU Berlin, Germany)

The presentation starts with a discussion of the experimental frame work, within a neurobiological approach to learning and memory may be realized. The goal of this approach is a synthesis of productive neurobiological concepts (e.g. unique identified neuron, multimodality of sensory neurons) and ethological concepts (e.g. quantification of behavioral patterns of freely behaving animals, consideration of the etho-ecological context of a behavioral pattern). The analysis of the learning behavior of honeybees has turned out to be a fruitful example for such studies. We are able to quantify learning behavior both, in freely flying bees and in those prepared for intracellular recordings from brain neurons. Simply behavioral responses normally occuring in freely behaving animals can be conditioned and released while recording from single neurons. Time dependend functions and event dependend functions are used to correlate behavioral and neurophysiological results.

7R-1,1

CHOICE OF OVIPOSITION SITES OF *DROSOPHILA MELANOGASTER*:GENETIC AND ETHOLOGICAL ASPECTS.

Takamura, T. (Dept. Biol. Tokyo Metropolitan Univ. Tokyo, 158)

When *D. melanogaster* females oviposite on the medium into which paper is stuck, significant difference is seen in the proportion of eggs laid on the paper among geographical strains. Artificial selection of flies brought about 2 lines, one preferred medium as oviposition site (M line) and the other preferred paper (P line).Direct observation of oviposition of these lines revealed that oviposition of *D. melanogaster* was a cycle of 4 behavioral components, actual oviposition, intensive extension and contraction of abdomen, walking and taking food, and an attempt to oviposite(examination of an oviposition site). The frequency of attempt to oviposite which took place on the paper and that of actual oviposition differed significantly between P and M lines. The fact that selection altered these two components means that at least these two components are under genetic control. It was also demonstrated that the attempt to oviposite was released by the information through tarsi and actual oviposition, by that through egg-guide.

7R-1,2

RADIOISOTOPE ^{32}P FOR THE ASSESSMENT OF HOST-PREFERENCE OF THE BROWN PLANT HOPPER (*Nilaparvata lugens* Stahl).

Sastrodihardjo,S. Bandung Reactor Centre.Indonesia

Radioisotope ^{32}P was used as a tool in the assesament of host-preference of the brown plant hopper. Brown hoppers (Biotype I) are fed with rice seedlings (IR5) containing ^{32}P. The best plants chosen for these experiments were IR26, IR28, IR30,IR32, IR34, IR36, IR38, IR40, IR5 and Pelita I/1. Individual radioactive hopper was kept in a glass vial containning individual host plant or combination of host plants. After 48 hours the hoppers were killed. The assessment of host preference was done by autoradiographing the seedlings on X-ray films. White spots on the film, which were the location of hopper punctures on the seedlings, were classified into 5 groups according to the diameter. Counts were made on the roots, leaves and stems of each seedling. The result of individual trials (one seedling one hopper) showed, that Mudgo group had more punctures than IR5 for Biotype I.
Grouped trials did not show the expected resul.

7R-1,3

INSECT - HOST PLANT INTERACTION : A "DEFENSE" MECHANISM OF PICEA EXCELSA AGAINST CHERMES ABIETIS. ROHFRITSCH O. (Inst. Botanique, U.L.P. STRASBOURG, FRANCE).

The fundatrix of Chermes abietis L. (Homopt., Adelgidae) causes one of the "pineapple" galls of the spruce (Picea excelsa L.). In automn, it feeds on the cortical cells of the shoot below the bud. These cells become modified, and form the primary nutritive tissue of the fundatrix larva. In the early spring, the insect feeds at the level of the cortical cells in the bud. These cells become modified and constitute the secondary and essential nutritive tissue of the fundatrix. The path of the mouthparts is always intercellular and is easily traced owing to the salivary sheat which the aphid secretes in the plant tissue. Each of spruce plant is susceptible for attack by alatae of Ch. abietis. But certain plants never develop galls. There is no sign of resistance in automn, the primary nutritive tissue is well developped. The resistance mechanism appears in spring, in reaction to a very intense "stinging" process of the larva, which causes cellular "irritation". Normally, the attacked area gives rise to the essential nutritive tissue, whereas in the resistant plant, the attacked cells, after a short period of activation, die.

7R-1,4

EVOLUTIONARY INTERPRETATIONS OF INSECT-HOSTPLANT RELATIONSHIPS. JERMY,T. /Research Institute for Plant Protection, H-1525 Budapest, Pf.102. Hungary/

The generally accepted coevolutionary theory of insect-hostplant relationships claims that /1/ insects are important selection factors in plant evolution,/2/ their attacks provoke evolution of defense mechanisms in plants, /3/ oligophagy is a "refuge" from competition with other insects and/or an "exile" to which the insects are confined by plant defense mechanisms.- It can be shown that neither of the main premisses of the coevolutionary theory can be proved for the majority of cases in nature. Therefore, the theory of sequential evolution is proposed: the evolution of the biochemical diversity of Angiosperms was one of the major factors in the evolution of phytophagous insects; the insects followed the evolution of plants in most cases without affecting the latter. The two types of evolution represent two ends of a scale with intermediates, however, the overwhelming majority of real cases belonging to the sequential type.

7R-2,5

FACTORS AFFECTING OVIPOSITIONAL BEHAVIOR OF THE YELLOW MOTH, DICHOCROCIS PUNCTIFERALIS GENUÉE. (LEPIDOPTERA; PYRALIDAE). Hiroshi Honda and Matsumoto,Y. (Dep. of Agr. Biol., Univ. Tokyo,113 Japan)

The yellow peach moth, is a fruit borer occurring in peach, plum,pear, persimmon, chestnut, and so on and the females lay eggs on many kinds of fruits. The mechanism of host plant selection has yet to be studied. The present experimental analysis suggested that both olfactory and physical stimuli are involved.

The surface texture of fruit, but not the shape was essential to induce their oviposition. Moisture had no appriciable effect on eliciting oviposition, though it had some effect against the most vigorous gravid females. Peach, apple and chestnut were prefered in that order. The steam distilates of fruit and the extracts with several organic solvents showed unstable or no activity for oviposition, nevertheless, unknown air-born stimuli of fruit had consistent activity. This factor(s), which was perceived through the antennal organs when proved with EAG or HCl-treatment, was deactivated with 2N potassium hydorate, but not with 2N hydrochloric acid. Further chemical characterization is under way.

7R-2,6 OVIPOSITION BEHAVIOUR AND KAIROMONE OF A PARASITOID, ASCOGASTER RETICULATUS WATANABE (HYMENOPTERA: BRACONIDAE).

Kainoh, Y., Hiyori, T.(Dept.Ent., Tokyo Univ. of Agri. and Technol., Fuchu, 183 Japan), Higuchi, H.(Nihon Women's Univ.) and Tamaki, Y.(Division of Ent., National Inst. Agri. Sci., Tsukuba, Ibaraki, 305 Japan)

A. reticulatus is an egg-larval parasitoid of the smaller tea tortrix, Adoxophyes sp. Host egg mass was recognized by female wasps by an olfactory stimuli in close to the host, and on contact with the surface of the egg mass, she walked actively back and forth on it and inserted her ovipositor into the eggs. Female's antennae were found to play an important role in this series of behaviour. Oviposition stimulant existed also in the hemolymph of female pupa and the ammount increases with the host's age. Also, the stimulant was found in the body fluid of male moth. As to the host preference of this wasp, she responded to the egg masses of at least two species of tortrix moth, Adoxophyes orana fasciata and Homona magnanima Diakonoff. This kairomone was heat stable and water soluble.

7R-2,7 HOST DISCRIMINATION OF THE PARASITIC WASP APANTELES GLOMERATUS L.(HYMENOPTERA: BRACONIDAE).

Ikawa, T. (Dept. of Agr. Biol., Univ. of Tokyo, Tokyo, 113 Japan)

Apanteles glomeratus inflicts great damage on the larvae of Pieris rapae crucivora, a pest of cruciferous crops. The percentage of parasitism sometimes reaches more than 90% in early summer. But the number of parasites per host is always about 25, which equals to the number laid by a wasp at one time. This fact suggests that the wasp can avoid superparasitism(Matsuzawa, 1958).

In the laboratory the wasp could discriminate the unparasitized hosts(U) from the parasitzed(P). The ratio of attacks by the wasp P/U was 0.24. First the wasp searched the host by the antennae, then stung with the ovipositor. The ratio of attack/antennal search against U was 0.44, while that against P was 0.12. The wasp seemed to deposit an oviposition-deterrent onto the surface of the parasitized host. Attachment of the female reproductive organ of the wasp to the body surface of unparasitized host reduced the attacks of parasite as much as 50%. The wasp could discriminate the parasitized hosts even after they molted. So this oviposition-deterrent was not enough to explain the mechanism of the host discrimination.

7R-2,8 HOST FINDING SEQUENCE OF APANTELES GLOMERATUS AND HOST SPECIFICITY.

Sato, Y. (Dept. Zool. Kyoto Univ., Kyoto, 606 Japan)

Parasitoids usually successfully parasitize only a limited number of host species, and the host specificity is mainly dependent on the steps involved in host-finding, and the factors involved in it were analyzed. A female wasp of Apanteles glomeratus is attracted by the leaf odor of the food plant of the host (Pieris rapae crucivora) and shows searching behavior on the leaf. Another olfactory stimulus from new damage left on the leaf by host larvae releases excitement behavior and continued intensive searching. Olfactory cue of a host larva attracts a nearby female wasp. It is means of this cue that the parasitoid female recognizes the species and the instar of host. Through these steps Apanteles parasitizes its usual host. Within an unsuitable host, parasitoid's eggs or larvae can not develop, being encapsulated by host hemocytes. Thus, a female is going to search a potential host larva without waisting time and loosing her eggs by unprofitable oviposition.

7R-3,9 AN ATTEMPT TO DISSECT THE CHEMICAL COMMUNICATION SYSTEM PREPARING THE MATING OF DROSOPHILA MELANOGASTER.

Jallon, J.-M., Antony, C., Iwatsubo, T. and Venard, R. (Centre de Génétique Moléculaire du C.N.R.S. - 91 190 Gif-sur-Yvette, France).

Our interest was first focused on the stimulus (or ensemble of stimuli) produced by a mature female which triggers the male courtship specific wing vibration (which we call female sex-appeal). A bioassay has been developped which clearly demonstrates that a chemical compound (or a mixture of chemicals) is a necessary part of sex-appeal. Parallel gas chromatographic studies -coupled with a few structural analyses- of either active female hexane extracts or inactive male hexane extracts have been performed in great detail, which suggest the aphrodisiac pheromone to consist of a sex specific cocktail of long chain hydrocarbons. To elucidate the role of each constituent, advantage was also taken of the existence of a female-like sex-appeal among young males which apparently vanishes about two days after eclosion and of the ability of D. melanogaster males to vibrate their wings in response to the sex-appeal of females of other species.

7R-3,10 A CHEMICAL STRUCTURE OF THE SEX PHEROMONE PRODUCED FROM FEMALE CIGARETTE BEETLE (LASIODERMA SERRICORNE F.).

Chuman, T., Kohno, M., Kato, K. and Noguchi, M. (Central Research Institute, The Japan Tobacco Public Corporation, Yokohama 227), and Mori, K.(Dept. Agr., Tokyo Univ., Tokyo 103)

Recently, we have started to study chemical control using a sex pheromone of cigarette beetle, which is a serious pest of cured tobacco leaves. Comprehensive investigation of excreta from female cigarette beetle accomplished to isolate the sex pheromone of this insect. In this report, we wish to describe on the chemical structure of the new sex pheromone including the stereochemistry.

Repeated column chromatography over silicic acid, of the acetylate (acetic anhyd. and pyridine) of hexane extract from 65,000 female cigarette beetle and preparative gas chromatography furnished the acetate of the sex pheromone. By the spectroscopic evidences (mass, ir, pmr and cmr) of the acetate and oxidative product of the sex pheromone with CrO_3, a structure of the sex pheromone is established as 4,6-dimethyl-7-hydroxy-nonan-3-one. The gross structure of the assigned feature was confirmed by its racemic synthesis. The stereochemistry of the three chiral centers at $C_{(4)}$, $C_{(6)}$ and $C_{(7)}$ will be discussed by the stereosel ive synthesis using optical active tartaric acid as the starting material.

7R-3,11 Sex pheromone of the comstock mealybug, Pseudococcus comstocki Kuwana.

Negishi, T., Uchida, M., Tamaki, Y. and Mori, K.

The sex pheromone produced by female of the Comstock mealybug, Pseudococcus comstcki Kuwana, was isolated(ca. 1.2 µg from 150000 females). The EI mass spectrum of the pheormone showed the following peaks:m/e 122, 113, 107, 69 and 43(base peak). The CI mass spectrum of the pheromone suggested that the molecular ion of the pheromone was 182(200-NH_4). The presence of a terminal methylene group is in accordence with the signal of hydrogen atoms at 4.7-5.3 ppm in the NMR spectrum. It could be shown by the signal at 1.63-1.73 ppm that the sex pheromone contained methyl branches on double bonds. Based on these data, the sex pheromone has been determined as 2,6-dimethyl-3-acetoxy-1,5-heptadiene. The synthetic pheromone was highly potent in field test.

7R-3,12 CONTACT CHEMORECEPTION IN THE MOTH SPODOPTERA LITTORALIS BOISD.,

Salama, H., Rizk, A. and Sharaby, A. (National Research Centre, Dokki, Cairo)

The distribution, structure and innervation of contact chemoreceptors of the moth *Spodoptera littoralis* have been investigated. Acceptance thresholds of the moths revealed that most pentoses, hexoses, di-and tri-saccharides were stimulating. Compounds with α-linkage were superior stimuli. Rejection thresholds to electrolytes showed a higher stimulating effectiveness of either acids or hydroxides than for neutral inorganic salts. A high degree of correlation was observed between the rejection thresholds of alcohols and their physical properties. An increase in the rejection threshold was proportionally correlated with the increase of the boiling point, molecular surface spherical, molecular surface cylindrical, molecular moment, standard free energy and activity coefficient. An inverse relation was observed between the threshold values, vapour pressure and distribution coefficient. Ketones proved to be less stimulating than aldehydes but more than the corresponding tested alcohols.

7R-4,13 EFFECT OF A MINOR COMPONENT, R-10-METHYLDODECYL ACETATE, OF THE SEX PHEROMONE OF ADOXOPHYES SP. ON SHORT RANGE MATING BEHAVIOR OF MALE MOTHS.

Kawasaki, K. (Div. Ent., Ntl. Inst. Agric. Sci., Tsukuba, Ibaraki, 305 Japan)

Sex pheromone of the smaller tea tortrix moth (*Adoxophyes* sp.) was identified as a mixture of two major components and two minor ones. The effect of minor components on the attraction for males and mating process was analyzed by observing their behavior in the laboratory. In flask bioassay, percentage of males that showed mating dance was increased by adding *R*-10-methyldodecyl acetate (*R*-10-Me-DA), one of the minor components, to the major components. When *R*-10-Me-DA was mixed with major components, most of the males displayed their mating dance around the pheromone-emitting filter paper on the bottom of the flask. Such behavior was not clearly observed without the minor component. When a piece of filter paper of major components was introduced together with that of *R*-10-Me-DA into a flask, most of the males gathered around the filter paper of major components. These results indicate that presence of *R*-10-Me-DA greatly enhance the orientation of males to the source of major components.

7R-4,14 SEX PHEROMONE SPECIFICITY OF TEA TORTRIX MOTHS, HOMONA MAGNANIMA AND HOMONA COFFEARIA.

Noguchi, H., Sugie, H. and Tamaki, Y. (Division of Entomology, Natl. Inst. Agric. Sci., Yatabe, Tsukuba, Ibaraki, 305 Japan)

Homona magnanima and *Homona coffearia* are economically important tortricid insects attacking tea plant in Japan and in south-east Asia. Sex pheromone components, (*Z*)-11-tetradecenyl acetate, (*Z*)-9-dodecenyl acetate, and 11-dodecenyl acetate have been isolated from *H. magnanima* and (*E*)-9-dodecenyl acetate, (*E*)-9-dodecenol, and dodecy acetate from *H. coffearia*. Results of detailed analysis on these pheromone components and related compounds in virgin females will be presented in this report with special reference to taxonomical relation between the two species.

7R-4,15 Isolating factors between the summerfruit tortrix and the smaller tea tortrix. Sugie,H., Tamaki,Y., Kitamura,T. and Sirasaki,S. (Natl.Inst.Agric.Sci.,Tsukuba,Ibaraki,305 Japan)

Through the studies on isolating factors between the summerfruit tortrix (SFT) and the smaller tea tortrix (STT) two additional sex pheromone components (10-methydodecyl acetate and (*E*)-11-tetradecenyl acetate) were found from STT females. However,analysis on the extract of SFT females did not show the presence of any other additional components. In field tests,addition of these compounds showed no effect on attractant activity of the synthetic SFT pheromone. So the existence of the two additional components will make it possible to recognize conspecific females for STT males. While the difference of mating time and ratio of majorcomponents may be important for SFT males to distinguish SFT females from STT females.

7R-4,16 MATING BEHAVIOR OF XYLOTRECHUS PYRRHODERUS BATES. Iwabuchi,K. and Takahashi,J.(Suntory Ltd.,Cent.Res.Inst.Yamanashi Lab.,Yamanashi,407-01 Japan)

Observations and experimental analyses of the mating behavior of Xylotrechus pyrrhoderus revealed its two sequence and importance of sex pheromone involved in the sequence. Flying females within about one meter distance are guided by the sex pheromone released from resting males. When the female lands at the place about ten centimeters apart from a male, the male is immediately excited by the sex pheromone released from the female, walks rapidly toward the female and then copulation is established.

7R-5,18 MATING DISRUPTION IN RICE STEM BORER MOTH, *CHILO SUPPRESSALIS* (WLK.) WITH POSSIBLE DISRUPTANT, Z-5-HEXADECENE. Tatsuki,S.,Uchiumi,K.,Kurihara,M.,Fukami,J.,Kanno,H.,Hattori,M.,Sato,A., Fujimoto,Y. and Tatsuno,T.(Lab.Insect Physiol.Toxicol.,Inst.Phys.Chem.Res.,Wako,351,Japan)

For the use of the mating disruption technique against *Chilo suppressalis*, of which sex pheromone was previously determined as a mixture of Z-11-hexadecenal and Z-13-octadecenal, we screened out Z-5-hexadecene (Z-5-HD) as a possible disruptant with more stability than the sex pheromone. Inhibitory effect of Z-5-HD on the male orientation to female-baited traps was found when either the compound was evaporated from dispensers in the traps or it was evaporated from dispensers surrounding the traps. Mating suppression with Z-5-HD was also observed in the field. A larger scale disruption experiment was then conducted to see if Z-5-HD could decrease the damage of rice plant by the next generation larvae in the field. Z-5-HD was treated to the paddyfields during the 2nd flight. The effect of the compound was evaluated immediately after harvest from the degree of injuries in the remained part of the plant. The degree of the injuries in the treated areas was shown to be significantly lower than those in the controls. Possible mechnism in the disruption was discussed in consideration of EAG and laboratory data.

7R-5,19 Behavioral function of male scent in Moths: Male-to-Male Inhibitory Pheromone

HIRAI, K. (Chugoku National Agricultural Experiment Station, Fukuyama Hiroshima,721 JPN

The behavioral function of a pheromone released by males of the armyworm moths, Pseudaletia unipuncta and P. separata was investigated in observations of mating behavior, mating tests, electroantennogram recordings, bioassays with a wind tunnel, and experiments with moth-baited traps in the field. Such male moth scent has been thought to act at close range as sexual stimulants for females of the same species. However, the only obvious effect of the P. unipuncta male pheromone was upon other males, decreasing their tendency to approach sexually receptive, pheromone-releasing females and to exhibit copulatory behavior when near those females. The adaptive significance of the male pheromone may be related to the increased reproductive efficiency that results if multiple males are prevented from competing for a single female.

7R-5,20 TERRITORIAL PHEROMONES REGULATING SPACING PATTERNS OF PHYTOPHAGOUS INSECTS

Prokopy, R.J., Crnjar, R.M., Averill, A.L., and Roitberg, B.D. (Dept. Ent., Univ.Mass., Amherst, Mass. USA)

In many insects, there is a range within which the density of individuals on an exhaustable unit of food resource is optimal, with selection favoring a high degree of individual fitness and full exploitation of the benefits of the resource, but not overcrowding. A considerable number of phytophagous insects - spanning at least 6 orders, 16 families, and 33 pest species -- release territorial pheromones which elicit the dispersal of arriving conspecifics away from food resources already occupied at densities near or above the upper end of the optimal range. In some species, such pheromones deter conspecifics from landing or feeding, while in others, they deter egglaying.

This paper will focus on the oviposition deterring pheromone system of apple maggot flies(Rhagoletis) as a model for the general case. Aspects to be covered will include: neurophysiology of pheromone reception; physiology of pheromone production; dynamics of pheromone release and protection of larval resources from overcrowding; and female foraging strategy in relation to pheromone-marked and unmarked oviposition patches.

7R-5,21 BIOLOGICAL ACTIVITY AND PERSISTENCE OF SPODOPTERA LITURA SEX PHEROMONE IMPREGNATED IN RUBBER SEPTA.

Hirano, C.(Pesticide Res. Lab., Kochi Univ., Nangoku-shi, Kochi, 783 Japan)

Rubber septa baited with 5mg of 'litlure', composed of 10 parts (Z,E)-9,11-tetradecadienyl acetate and 1 part (Z,E)-9,12-tetradecadienyl acetate, the active components of Spodoptera litura sex pheromone, caught many males when they were used in plastic-box traps. Rubber septa baits were effective for 1 month with decreasing effectiveness, and were practically ineffective after 2 or 3 months. Determinations of 'litlure' retained in rubber septa taken from the field trapping experiments showed that the half lives were 36 days and 33 days for the major and minor components, respectively. The relative attractiveness of aged rubber septa and quantity of 'litlure' retained in the septa correlated closely. The disappearance rate of tetradecadienyl acetates was about twice as fast as the rate of tetradecenyl acetates, indicating that the loss from rubber septa may be due to not only evaporation but decomposition.

7R-6,22 ORIENTATION TO THE FEMALE SEX PHEROMONE, PERIPLANONE B, IN MALE AMERICAN COCKROACHES. Tobin, Thomas R. (Dept. Ent., Univ. Kansas, Lawrence, Ks 66045)

The orientation responces of the male American cockroach to synthetic female sex pheromone, Periplanone B, was investigated utilizing a low speed wind tunnel. Computer assisted analysis of the photographically recorded orientation pathway enabled comparison between different stimuli. The evidence for "reversal anemotaxis" is considered from the orientation within pheromone plumes of different widths.

7R-6,23 SIGNIFICANCE OF THE ATTRACTION OF THE PERIPLANONE B TO THE MALE ADULTS OF *PERIPLANETA AMERICANA* (L.) IN RICE BARN. Chow, Y. S. (Inst. Zool. Acad. Sinica Taipei Taiwan 115

The square box trap baited with crude sex pheromone extract from females or food such as fried peanut is better than the rectangular trap. Japanese-made sticky traps baited with lure SR-75 are very good for the attraction of small cockroaches, especially for the German cockroach or nymph of the American cockroach. Synthetic (±) periplanone B (0.01 μg to 1 μg) placed within a square box trap can attract more males of *Periplaneta americana* (L.) than food bait alone. Other related chemicals, D or L-bornyl acetate and germacrene-D, can also elicit strong sex response in the males of American cockroach in laboratory bioassays at high concentration but fail to give a positive dosage-response relationship.

7R-6,24 A DEFENSIVE BEHAVIOR OF THE COCKROACHES, *PERIPLANETA FULIGINOSA* AND *P. JAPONICA* IN RELATION TO THEIR VISCOUS SECRETIONS. Ichinosé, T. and Zennyoji, K. (Ent. Lab., Fac. Agr., Tokyo Univ. of Agr. & Tech. Fuchu, 183 Japan)

The function of the viscous secretion on the tergal terminal segments of abdomen and cerci of cockroach has not been finally established. Nayler (1964) considered the secretion from the cockroach *Pseudoderopeltis bicolor* to be of value as a means of incouraging predators that came in contact with it. The authors' experiment and observation, however, revealed a characteristic counteroffensive behavior in the nymphs of both species, *Periplaneta fuliginosa* and *P. japonica*, in relation to their viscous secretion. This behavior consists of turning of the caudal tip toward enemies (aggressive ants), stretching their legs and fast shaking the caudal tip. It was found to be a means of splashing droplets of the secretion over several centimeters. *Periplaneta americana* having no or little secretion did not exhibit such a behavior, being seriously vulnerable.

The viscous secretion is principally of protein, and accumulates on the 6th and 7th tergites as well as on cerci of all of the nymphs, particularly, when they were reared solitarily or in a few numbers in large container. The dorsal gland had no relation to the secretion, and the hypodermal cells corresponding to the viscous area seem to be the source of the secretion as proved partially in *Pseudoderopeltis* by Nayler. The stout hairs found on the viscous area may have likely some rôle, since they exist in parallel with the secretion.

7R-6,25

ORIENTATION OF COCKROACHES ON A SERVOSPHERE APPARATUS.

Bell, William J. (Dept. Ent., Univ. Kansas, Lawrence, 66045)

Orientation responses of the cockroach Periplaneta americana to wind and sex pheromone was monitored using a servosphere apparatus. Orientation mechanisms investigated include local search, chemotaxis and anemotaxis.

7R-7,26

BREEDING BEHAVIOR OF Mnais pruinosa SELYS.

Iwasaki, M. (Dept. Zool., Kyoto Univ., Kyoto, 606 Japan)

Species complex of Mnais pruinosa SELYS presents many interesting problems. Observations of the mating strategy of M. p. pruinosa were examined in Kyoto where only hyaline winged type is distributed and suggest the character displacement in M. p. costalis and M. p. pruinosa.

7R-7,27

INTERACTION OF MALE AND FEMALE MIDGES, ANARETE PRITCHARDI KIM, LEADING TO COUPLING (DIPTERA: CECIDOMYIIDAE).

Chiang, H. C., Goldsmith, A. and Okubo, A. (Dept. Entomology Fisheries & Wildlife, Univ. of Minn. St. Paul, Minn. 55108, U.S.A.

Movement of female and male midges, Anarete pritchardi Kim, in a swarm prior, during and following coupling was described in five cases. Along with two couplings described in an earlier paper, a possible cue of interaction leading to coupling was identified, namely a sharp turn of the female, a sharp turn of the male, then followed by the converging of flight paths. The male then eased up to the female to make contact.

7R-7,28 TERRITORIALITY AS A DENSITY-DEPENDENT MATING STRATEGY IN *CORDULIA*.

Ubukata, H. (Kushiro College, Hokkaido Univ. of Education, Kushiro, 085 Japan)

Adult males of *Cordulia aenea amurensis* Selys (Odon.) occupy territories at high population densities, whereas they search over a long distance along the pond shore at low densities (Ubukata, 1975). The rate of aggressive encounter increases with the male density (M, per m shore) of the whole pond. The average length (L m, measured along the shore) of a 'patrol range' decreases with M according to an empirical formula: $L = 4.96^{-0.33}$. The ratio of victory in fighting of a given male increases with contraction of his patrol range. This 'effect of prior residence' is attained within a couple of minutes after localization. The ratio of male density at sector 'NE', at which the predictability of female arrival is highest, to M decreased according to an increase of M. This suggests a promotion of dispersal of males from NE to the other sectors due to the aggression by the territory occupants at NE. Based upon a simple 'patrolling model' the relationships among patrol range, population density and mating success are discussed.

7R-8,29 COMPARATIVE STUDIES ON THE STRUCTURES AND SPECTRAL SENSITIVITIES OF LEPIDOPTERAN COMPOUND EYES.

Eguchi,E.(Dept. Biol.,Yokohama City Univ.,Yokohama, Japan

The rhabdom structures by electron microscopy and spectral sensitivities (400-700nm) by electroretinogram were comparatively studied on the compound eyes of many different lepidopteran species such as diurnal, nocturnal and intermediate types with reference to their behaviours and light environments. Most diurnal species have small size of rhabdom with regularly arranged microvilli and have the spectral sensitivities of λmax= 560nm with secondary peak of about 460nm except skippers. Most of nocturnal species , however, have larger size of rhabdom with microvilli arranged in all directions and have the spectral sensitivities of λmax= 510nm with secondary peak at about 460nm. It may be said that the rhabdom structures and color visions of lepidopterans can be classified by the view point of their light habitats and behaviours rather than the view point of their taxonomical positions.

7R-8,30 Ontogeny of Insect Flight - Similarities in Neurogenic and Myogenic Fliers

W. Kutsch, Fac. Biology, Univ., Konstanz, W. Germany

In insects two principles of muscle activation have been developed by which the movements of the wings in flight are generated: the neurogenic or synchronous and the myogenic or asynchronous mechanism. Numerous publications demonstrated the differences in the nervous control of these two flight types.

Ontogenetic studies reveal a flight motor pattern that is basically similar in young and old adults. Only the rhythm of the motoneuronal output fastens leading to a higher wing-beat frequency in mature adults. The results of various experimental interferences let assume that the basic flight motor program and its ontogeny is of central origin. The results are similar for insects of both flight types pointing towards similar central processes and suggesting a general Principle valid for all flying insects.

7R-8,31

ORIENTATION IN STIMULUS GRADIENTS BY A MODEL ANIMAL: KLINOKINESIS REASSESSED.

Havukkala, I. (Dept. of Zoology and Applied Entomology, Imperial College, London)

The behaviour of hypothetical animals in linear stimulus gradients was simulated with a digital computer. In the experiments the 'animals' were released from the centre point of a two-dimensional space. After each step the direction of the following step was determined by taking a random sample from a specified angular distribution with a mean of 0 degrees and a range of -180 to +180 degrees, where negative and positive values indicate a turn to the left and right, respectively. The length of each step was made proportional to the value of the x-coordinate of the animal's position so that the direction of the 'gradient' was parallel to the x-axis to simulate orthokinesis. Klinokinesis was simulated by increasing the probability of a greater turn occurring (by increasing the circular variance of the angular distribution) with increasing values of x-coordinates of the animal.

Contrary to the conclusions of Gunn and other authors, klinokinesis without adaptation was found to cause ultimately a net movement along the gradient toward the area of less tortuous walking. In the initial phase of movement, however, each individual spent the largest amount of time in the area of extensive turning. Orthokinesis also caused a skewed distribution of positions along the gradient indicating the trapping effect of arrestment behaviour. When klinokinesis and orthokinesis were combined, and cooperating, the net displacement was markedly greater. When the two mechanisms counteracted, the result was a bimodal distribution with one peak in the area of slow movement and extensive turning; the net displacement depended on the relative strength of orthokinesis and klinokinesis. Various indirect orientation mechanisms in different situations are discussed.

7R-8,32

THE USE OF A COMPUTER CONTROLLED SERVOSPHERE SYSTEM IN BEHAVIOR EXPERIMENTS

Surber, James L. (Dept. Ent., Univ. Kansas, Lawrence, Kansas 66045 USA)

A servosphere locomotion compensation system has been used in conjunction with computer controlled devices to produce simulated stimuli for behavior experiments. The system as a whole is discussed with emphasis upon the generation and computer control of pheromone concentration and wind parameters.

7R-8,33

Flight Mechanism Of Beetles.

Flight mechanism in beetles, Prof. Dr. Peter Schneider, Im Neuenheimer Feld 293, D-6900 Heidelberg 1, Germany.

In Coleoptera, we can distinguish four flight types (Abb.1):
a) Cicindela-type b) Melolontha-type c) Cetonia-type d) Necrophorus-type.
Importance, position and kind of motion of elytra are described in these four flight-types (Abb.1).
In all beetles, the elytra are moved indirectly by the oscillation of the metathorax, whose oscillation is transferred to the posterior tergal levers of the mesothorax, and the mesoscutum swings around a functional point of rotation. This swinging is transferred by the anterior tergal levers to the axillary sclerite 2, which is connected and articulated to the elytral joint (Abb. 2).
Horizontal changing of direction and climbing flight are caused by changing and shifting of the amplitude (Abb. 3). The path of the wing tip is described; the most important part is a loop-like motion in the lower part of the amplitude (Abb. 4). The mechanisms of climbing flight and braking to shivering are described and explained with vectorial forces (Abb. 5-7).
Start maneuvers and the kinematics of wings are documented by a short film (1,5 minutes).

7R-9,34 THE FUNCTION OF SOUND IN MALE SPACING BEHAVIOUR IN BUSH-CRICKETS (TETTIGONIIDAE: ORTHOPTERA).

Dr. W.J. Bailey, Dept. of Zoology, University of Western Australia.

The male bush-cricket, Mygalopsis marki Bailey, establishes a territory based on the perceived intensity of the call of conspecific males. This genus is remarkably non-vagile and there is little song interaction, and is therefore readily manipulated in the field. We have been able to establish by field experiment that males aggregate and that within these aggregations males maintain a constant between male distance.

7R-9,35 ACOUSTIC BEHAVIOR OF THREE SPECIES OF HYLOBIUS (COLEOPTERA, CURCULIONIDAE).

Jansson, A. (Zool. Mus., Univ. Helsinki, SF-00100 Helsinki 10, Finland)

Males of H. abietis, H. piceus, and H. pinastri are able to stridulate by rubbing tubercles, located on dorsum of the 7th abdominal tergite, against series of ridges on inner edges of the elytrae; in females the stridulatory structures are rudimentary, and the females were not observed to stridulate. The males stridulated in the following situations:

1) Protesting: When held with fingers or forceps, the males usually produced a series of signals.

2) Disturbance: In aggregations, or if mounted by other males in erroneous mating attempts, the males that remained underneath responded by stridulating.

3) Courtship: Behaviorally the most significant stridulations were probably those observed during courtship displays: When mounting females, the males always produced a series of signals before attempting genital contact; response of the females to these courtship signals was either to remain stationary and allowing the males to proceed with mating (evidently receptive females) or to escape by running away (presumably unreceptive females).

Interspecific behavioral experiments revealed that species recognition was based on pheromones; only occasionally did the males approach other than conspecific individuals, and in the very few cases when such approach led to an attempt at mounting, the males turned away already before beginning to stridulate. Thus, the stridulation of Hylobius males does not seem to play a role in premating isolation of the species, but it does confirm the sex and the receptiveness of the females.

7R-9,36 DENSITY RELATED EMISSION OF THE MALE VIBRATION SIGNAL AND ITS POSSIBLE ROLE IN THE BROWN PLANTHOPPER, *NILAPARVATA LUGENS* (HOMOPTERA : DELPHACIDAE).

Ichikawa, T. (Lab. Appl. Ent. Kagawa Univ., Miki-tyo, Kita-gun, Kagawa, 761-07 Japan)

The brown planthopper was revealed to communicate alternately between opposite sexes through vibration signals via the rice plant in the mating behavior (Ichikawa, 1976).

In addition to the emission of the vibration signal (VS-1) similar to those emitted in the mating behavior, males sometimes emitted another vibration signal (VS-2) when they were staying on the same rice plant. VS-2 seemed to be rival signal. Males come to emit VS-2 more frequently with the increase of adult density. Males individually reared at adult stage never emit VS-2 irrespective of nymphal density. Not only VS-1 but also vibrations caused by the scrape of legs on the rice plant by both sexes induce the emission of VS-2 of other males.

These results suggest that the role of VS-2 is not restricted to male-male interactions, but is related to some aspect of adult life of both sexes existing on the same rice plant.

7R-10,37 STUDISE ON THE MATING BEHAVIOR OF THE SWALLOWTAIL BUTTERFLY OF TROIDINI, *ATROPHANEURA ALCINOUS* (LEPIDOPTERA : PAPILIONIDAE). Ohto, K., T. Ichikawa and Y. Miyamoto (Lab. Appl. Ent. Kagawa Univ., Miki-tyo, Kita-gun, Kagawa, 761-07 Japan)

Experimental analyses on the mating behavior of *A. alcinous* were carried out.
Males are attracted to the black object of the size of resting female with closed wings. When males approach resting females, they touch females on the wings with their forewings and legs. Then females lower their forewings by physical stimuli given on the anterior margin of forewings by males. Such female behavior releases the male copulatory attempt. Thus the mating behavior of this species at resting phase is successively released by the recognition of stimuli from opposite sex in each step of precopulatory behavior. Males pursue flying adults of both sexes. The duration is within 2 sec. in male-male pursuit compared with the duration of male-female pursuit of more than 10 sec. Virgin females alight after the pursuit, and the mating behavior at resting phase ensues. Male adults possess characteristic odor. It is considered that this odor may be the cue to discriminate the sexes at aerial phase.

7R-10,38 COLOR AND COLOR-PATTERN IN THE SEXUAL BEHAVIOR OF MALE SWALLOWTAIL BUTTERFLY. Yamashita, K. (Entomological Laboratory, Kyoto Prefectural University, Kyoto, 606 Japan) and Hidaka, T. (Dept. Zool., Kyoto Univ., Kyoto, 606 Japan)

Japanese common swallowtail, Papilio xuthus, has a characteristic color pattern of black-and-yellow stripes. Former experiments show that a dummy or abstract model with this character could attract males of this butterfly, and that this "yellow" could be replaced by viridian poster color (Hidaka and Yamashita, 1976, 1977).
Further experiments revealed that male sexual behavior consists of 1) "Random" flight along vegetation; 2) "Searching" flight around food plant; 3) Approach to the female or an object equivalent to it; 4) Examination at a very short distance from the object; 5) Contact to it with the tip of fore-legs; and finally 6) Copulatory attempt and copulation. The approach and examination are released by the "yellow" part of the female wing or the viridian color only, but the contact behavior is released only when this color was combined with black in a striped pattern. If both black and "yellow" parts of the model are made of pieces of real female wings, male contacts it, but the percentage of Contacts decreases when the model is fabricated otherwise.
When an intact female dummy or a strongly effective model is placed on a card painted white, yellow, red or blue, even the Approach of males to these objects are considerably or completely inhibited. Similar inhibition of sexual behavior is observed when these colors are inserted between two black-and-viridian stripe-sets.

7P,1 " WARNING COLORATION " IN LARVAE OF A DIURNAL MOTH, PRYERIA SINICA MOORE (LEPIDOPTERA, ZYGAENIDAE). Johki, Y. (Dept. Zool., Kyoto Univ., Kyoto, 606 Japan)

Pryeria sinica belongs to the day-flying moth group, family Zygaenidae, and a larva of this species has relatively conspicuous, yellow and black color patterns. When pressed, this larva secretes drops of fluid with peculiar smell on the body surface and this secretion tastes bitter to humans. It is therefore likely that the conspicuous body color of this larva serves as the " warning coloration " for the predators. In order to test this possibility, Pryeria larvae were given to caged lacertid lizards, Takydromus tachydromoides. Pryeria larva was protected perfectly from attacks by the lizards because of peculiar-smelling fluid, and yellow and black body color of this larva had a meaning as the " warning coloration " at least for a lizard. Characteristics of predatory behavior in Takydromus were also analyzed and it was indicated that not only visual cues but also other facter(s) played important role in the process of recognition and choice of preys. Such a system appeared to be considerably different from that of birds.

7P,2 PROTECTIVE FUNCTION OF EYESPOT PATTERNS IN LEPIDOPTERA AND CONSERVATISM OF BIRDS.

Yamaguchi, R and Sirota, Y (Laboratory of Entomology, Faculty of Agriculture, Hirosaki Univ., Hirosaki 036, Japan)

The avoidance response of birds to eyespots and other conspicuous patterns or coloration might be due to the behavior patterns either genetically fixed or formed through the process of learning. There are conflicting opinions as to this point. We examined the protective function of eyespot patterns and conspicuous colorlation particularly in relation to the experience of birds. Two types of preys, familiar and unfamiliar, were offered to the choice by hand-reared starlings. Familiar preys were normal larvae of Bombyx mori and unfamiliar larvae were painted to show various color spots, eyespots, or bands. The former had previously been presented several times, but the latter only once in a choice experiment. The birds tended to avoid edible but unfamiliar caterpillars, and the magnitude of change in visual stimuli seemed to be important in determing the birds responses. The protective effect of eyespot patterns might depend on the conservatism in the response of birds to strange and novel colors and patterns, and not on their resemblance to "predator eyes".

7P,3 SYNERGISTS TO ONION FLY ATTRACTANTS IN THE LARVA-CONDITIONED ONIONS.

Ishikawa, Y., H. Ono, T. Tsuchiya, T. Ikeshoji and Y. Matsumoto(Dept. Agr. Biol., Univ. of Tokyo, Tokyo 113, Japan)

We revealed that an Erwinia-like bacterium is responsible to the enhanced attractivity of larva-conditioned onions by producing ethyl acetate and tetramethyl pyrazine. Though these compounds were not attractive by themselves, they synergized the attractive propylthio compounds such as di-n-propyl disulfides in onions significantly. With the screening tests extended to the related esters, alcohols acids and amines, we found ethanol and propanol to be the synergists, while several acetates with a methyl branch in their alcohol portion to inhibit the attractivity of the sulfur compounds. EAG responses to the propylthio compounds were consistently higher than those to the unattractive sulfur and oxygen compounds. However, ethyl acetate, the potent synergist, elevated the response to di-n-propyl disulfide significantly when these were applied in mixture. To obtain further information concerning interaction between the receptors and these molecules, a single cell recording study is under way.

7P,5 THE CHEMICAL ECOLOGY OF BARK BEETLES COLONIZING PONDEROSA PINE.

Wood, D.L., Bergot, B., Browne, L., Byers, J., Elkinton, J., Fish, R. and Hendry, L. (Dept. Ent. Sci., Univ. of Calif., Berkeley, Calif. 94720, U.S.A.)

Evidence indicates that Ips paraconfusus does not discriminate between a host and non-host (white fir) prior to landing on the tree. After landing, the male first orients to a fissue in the bark and then excavates a tunnel into the upper surface of the phloem in both the host and non-host. Sustained feeding occurs in the host in response to feeding stimulants, while the entrance tunnel in the non-host is abandoned prior to sustained feeding. The feeding and boring stimulants are ether extractable. When confined to artificial entrance tunnels in white fir, the pheromone components ipsdienol and ipsenol are produced.

Sympatric tree-killing species have evolved highly specific pheromones as well as allomones that interrupt the attractive response of potentially competing species to their own pheromones. These allomones can be pheromone components of competing species or other behavior-modifying chemicals.

Recent deuterium labelling experiments have demonstrated that a host plant terpene, myrcene, is directly converted to ipsdienol, ipsdienone and ipsenol and ipsdienone is converted to ipsdienol and ipsenol. These conversions are enantiospecific.

7P,6 The Role of Mandibular Gland Substance in Social Enhancement during Digging by the Ant, Camponotus japonicus. Imamura, S. (Zool. Inst., Hokkaido Univ., Sapporo, 060 Japan.)

The mandibular gland substance of ants is known as an alarm pheromone. But some previous surveys have shown that at least under some particular conditions this substance can release and enhance digging activity also. In the present study I show that this pheromone is excreted in coordination with the movement of mandibles during digging. It is further assumed that, as one digging ant excrete the substance, it stimulates other workers to join the task, provided the latter ones are also in the mood of digging. Thus, the mandibular gland substance seems to play an important role in the social facilitation in digging by ants, which was reported by Chen in 1937 but has been suspected by later researchers.

7P,7 BEHAVIORAL ECOLOGY OF TWO SPECIES OF BLACK SWALLOWTAIL IN AN ISOLATED POPULATION. Niizuma, A. (Dept. Zool., Kyoto Univ., Kyoto, 606 Japan), Ban, Y., Hidaka, T., Kiritani, K., Miyai, S., Nozato, K., Suzuki, N., Watanabe, M. and Yamashita, K.

Two species of genus Papilio (P. helenus and P. protenor) were studied in an isolated population, Kotakasaka-yama, Kochi Prefecture. Both are rather typical inhabitants in forest, and have black wing color. Some aspects of their biology have been studied for these 4 years.
POPULATION STUDIES were made by the marking-and-recupture method, taking advantage of their habit of "Hill-topping". Numbers of individuals marked were about 1,000 (total of both species) for each year, and almost of them were males. Population size of each species was estimated by Jolly-Sever method, and also life span and survival curve were determined.
Life span of adult male was about 15 days for both species. Maximam density, in summer of 1978, for example, was 17.5/100m and 26.9/m for P. helenus and P. protenor respectively, which was very low, even if females were taken in count, but their density remained stable.
Their population dynamics and the life table of larvae on host plant will be also discussed.
SEXUAL BEHAVIOR of these species was studied by experiments with the use of dummy and models painted by poster colors. It was revealed that black board could attract males of both species, though there were slight differences between two species in behavior patterns of Approach, Examination and Contact.
FORAGING BEHAVIOR, TIME-ALLOCATION etc. were also studied to compare the life history strategies of these two species of butterflies.

7P,8 SURFACE PHENOMENA AND INSECT LIFE. Baudoin, R. (34, Avenue de l'Abbaye, 91330 Yerres, France)

The surface phenomena-- meniscus, wetting, surface tension-- are found on all the transition between air and water.

All insects are subject to or actively utilise the surface tension: aquatic insects (Aphelocheirus, some larvae etc.), amphibian insects (Dytiscus, Hydrophilus, Notonecta etc.), skaters, predators of surface, runners and walkers of surface (Gerris, Halobates, Velia, Hebrus, Mesovelia, Hydrometra, Aepophilus).

Habitats of intertidal-zone insects (Crevices, alveolate sands) are products of surface forces.

Solid films secreted by bacteria and weeds form a firm floor, utilised by small shore arthropods that never venture on the water surface not covered with such bacterial films.

7P,9 CRADLE FORMATION OF CHONOSTROPHEUS CHUJOI VOSS--AN ETHOLOGICAL STUDY.

Sakurai, K. (Dept. Zool., Kyoto Univ., Kyoto, 606 Japan)

Most of the attelabiid weevils have characteristic ovipositional habit: female constructs a leaf roll of definite shape, which is called "cradle", within which eggs are deposited. It was demonstrated that the female Chonostropheus chujoi decided the size of a cradle according to the whole size of the leaf used. Young oak leaves (Quercus serrata) which were cut in the shape of ellipses differing in size and/or ellipticity were given to the female weevils in order to investigate by what means they measured leaf size and how they decided the site of the first cut. It was revealed that the female weevil does not measure leaf area, but probably the length along the main nerve or that of circumference. The starting point of the measurement is not the end of the main nerve but simply the most protruded point of the leaf. The site of the first cut fluctuates more, when a leaf exceeds a certain length.

7P,10 Feeding behavior of the ladybeetle, *Coccinella septempunctata*.

Nakamuta, K. (Laboratory of Applied Entomology and Nematology, School of Agriculture, Nagoya University, Nagoya, 464 Japan)

Feeding behavior of the ladybeetle was consisted of stationary, prey-searching, prey capture, consumption of prey and grooming of antennae or maxillary palpi. Prey-searching was a hunger-dependent behavior, and was not observed during dark period in both greenhouse and laboratory conditions. The tracks of the beetle in searching for prey tended to be straight before prey capture. After having captured an aphid, the beetle decreased forward movement and searched for another prey near the vicinity. This change in searching behavior was not usually maintained for more than a few minutes when no prey was found nearby, and the beetle reverted to the searching pattern as before. Since the aphids usually live in clusters, this searching pattern is considered to be advantageous for the beetle. To capture their prey, the mechanical contact of the head of the beetle, especially the mechanical contact of the maxillary palpi of the beetle was important. Subsequent to the mechanical contact, a chemical contact may occur in captureing their prey.

7P,11 THE ROLE OF LEARNING ON FINDING OF FOOD IN THE SEARCHING BEHAVIOUR OF THE HOUSEFLY, MUSCA DOMESTICA.

Fukushi, T. (Dept. Biol., Miyagi Coll. Educ., Sendai, 980 Japan)

On consuming a droplet of sugar solution, a hungry fly performs the searching behaviour, gyrating around the food source (Dethier, 1957). This behaviour enhances the probability of finding of other foods scattering around the food source. Larger efficiency to find foods would be expected when the fly can associate signals belonging to food with the food. Such an ability can be expected from the sucesses of conditioning, in which the fly extends its proboscis in response to conditioned stimuli (Frings, 1941; Nelson, 1971; Fukushi, 1973, 1976, 1979).

In this paper, freely walking houseflies, Musca domestica, were presented a sucrose drop with an odour and tested for finding of other sucrose drop with the odour in the searching behaviour elicited by sucrose. The flies found preferably the sucrose drop with the odour contained in food ever ingested. This behavioural modification was odour-specific and decayed with time. These results suggest that the fly can learn signals marking food in association with the food and use the stored information for finding of food.

7P,12 HYMENOPTEROUS VENOMS: BIOCHEMICAL COMPOSITIONS, PHARMACOLOGICAL ACTIVITIES AND PHYLOGENETIC RELATIONSHIPS. Schmidt, J. O., Blum, M. S. and Overal, W. L. (Dept. Ent., Univ. Georgia, Athens, GA USA; Dept. Ent., Museu Paraense, C. P. 399 Belem, PA, Brazil.

The venoms of social aculeate Hymenoptera including ants (Pogonomyrmex comanche, P. rugosus, P. barbatus, Ectatomma tuberculum, E. quadridens, Paraponera clavata, Eciton burchelli, Pseudomyrmex triplarinus, Pachycondyla laevigata, P. crassinoda, P. apicalis, Odontomachus haematodus, Platythyrea cribrinodis, Dinoponera gigantea), wasps (Vespula squamosa, Polistes infuscatus, Paravespula maculifrons, P. flavopilosa, Polybia chrysothorax, Apoica pallens), and bees (Bombus impatiens) and of a solitary wasp (Dasymutilla klugii) and a solitary bee (Xylocopa virginica) were investigated. Phospholipase A_2 enzymic activities were elevated in most of the venoms of the social Hymenoptera and were relatively low or absent in the solitary Hymenoptera. Hyaluronidase enzymic activities were highly variable in the venoms and exhibited no apparent relationships to either taxonomic or social status of the hymenopterans. The ability of the various venoms to lyse erythrocytes was also variable. The lethalities (LD_{50}, i.p., mice) of the venoms ranged from 0.3 mg/kg for Pogonomyrmex comanche to 71 mg/kg for Dasymutilla klugii. No evident correlations between taxonomic status and lethality were observed. In summary, hymenopterous venoms present a mosiac of lethal, enzymic, and pharmacological activities which appears to preclude a priori generalizations relating taxonomy and activity.

7P,13 SENSORY PATHWAYS BETWEEN THE BRAIN AND THE THORAX IN THE HONEYBEE, APIS MELLIFERA.

Goodman, L.J. , Mobbs, P.G., Pan, K.C. and Guy, R.G.

The ocelli have a direct pathway to the thorax via ten large first order interneurons. These cells arborize amongst the branches of certain motor neurons within the dorsal neuropile of the thoracic ganglia. The motorneurons innervate the muscles responsible for abdominal bending and muscles involved in the production of wing movements. Sensory neurons innervating the forewing arborize within the thoracic ganglia and also ascend to the perioesophageal region of the brain where they terminate amongst small ocellar tract fibres. The possible functional significance of some of these pathways will be discussed.

7P,14 Taste responsiveness of the transplanted supernumerary leg in the fleshfly (Sarcophaga bullata). Sivasubramanian, P. (Dept. Biol., Univ. New Brunswick, Fredericton, N.B., Canada)

In Diptera, the leg imaginal discs (bags of highly determined but undifferentiated cells) give rise to the adult legs. By a special method of ectopic transplantation the prothoracic leg disc was induced to differentiate into normal looking supernumerary leg on the abdomen of the fleshfly. Microdissection of the ectopic leg revealed the presence of a nerve between the leg and the host's CNS, and this nerve projected into the appropriate neuromere in the thoracic ganglion of the host fly. Topical application of sugar solution to the tarsal taste receptors of the supernumerary leg elicited only partial extension of the proboscis. It is suggested that although the nerve axons of the supernumerary leg project into the proper nueromere of the thoracic ganglion, their subsequent impulse transmission to subesophageal ganglion and thence to the motor fibers that control the extensor muscles of the proboscis may be impaired.

7P,15 NEUROETHOLOGICAL TESTS OF BEHAVIOUR OF HONEY BEE (APIS MELLIFICA L.) UNDER THE INFLUENCE OF PHEROMONE STIMULUS. Skirkevičius, A., Vaitkevičienė, G., Skirkevičienė, Z. (Inst. Zool. and Parasitol., Lithuanian Acad. Sci., Poželos 54, Vilnius, USSR)

The bees from queen's retinue were used in the tests for behavioural reactions tothe activity of bee queen's pheromones. It was determined that season and age of worker bees have influence in relation to pheromonal stimulus. The sensitivity to pheromone changes depending on the age even at the level of receptors of olfactory analizer of bee. It can be one of the reasons for differences in receptor responses of separate individuals of the same family when given the same stimulus. The state of higher levels of olfactory analizer changes with age. Besides the efficiency of both receptory and higher levels of the given bees' sensory system is influenced by the season of the year.

7P,16 "The sliding coupling mechanism in four-winged Insects with asynchronous flight motor" Prof. Dr. Peter Schneider, Im Neuenheimer Feld 293, D-6900 Heidelberg, Germany.

The necessity for a sliding coupling mechanism between forewing and hindwing is shown on the basis of wing movement and morphological in Hetereoptera, Cicadas (Auchenorrhyncha) and Hymenoptera.

1. Heteroptera: The sliding coupling mechanism consists of a sliding throught which is formed from a sliding head and a sliding comb, both covered with microtrichia. The sliding through is located on the underside of the hind edge of the forewing. The front edge of the hindwing is bent in a double S - shaped fold that slides in the sliding through of the forewing.
2. Cicada: Here the relationship are the reverse of the heteropteran case. The sliding coupling mechanism is based on a sliding bar, a raised, sometimes folded, portion on the upper side of the front edge of the hind wing. A simple S - shaped fold of the hind edge of the forewing inserts behind this sliding bar. Here, too, microtrichia serve to reduce friction. The coupling is maintained solely by the pull of the hooked-in forewing.
3. Hymenoptera: Conditions as in the cicidas, expect that the short sliding bar replaced by a somewhat longer row of hooks. These hooks are twisted in a cork-screw spiral and allow a nearly frictionsless sliding.
4. The necessity for a sliding coupling mechanism and its possible evolution are discussed.

7P,17 INTRACELLULAR RECORDINGS FROM THE RESPIRATORY MOTONEURONS IN THE DRAGONFLY LARVAE, Anax parthenope julius. Komatsu, A. (Dept. Physiol., Tokyo Women's Medical College, Tokyo, 162 Japan).

Intracellular recordings were made with microelectrodes penetrating neuropilar regions of respiratory motoneurons in the 4th abdominal ganglion of the dragonfly larvae. During spontaneous rhythmic activities recorded from nerves innervating respiratory muscles, the motoneurons showed burst of spikes superimposed on the depolarizing phase of their oscillatory membrane potential. EPSP's and IPSP's were observed in some motoneurons. Injection of depolarizing current pulse into a respiratory motoneuron produced spike discharges, but it neither altered the rhythmicity nor affected activities of other motoneurons. Therefore the respiratory motoneurons appear to behave merely as output elements which relay the activity of an oscillator(s). Long-lasting hyperpolarizing current injected into an inspiratory motoneuron enhanced the inspiratory depolarizing potential, while it reduced the expiratory hyperpolarizing potential which reversed its polarity by increasing current. It is suggested that the inspiratory depolarization is caused by excitatory inputs and the expiratory hyperpolarization by inhibitory ones, and that these inputs are mediated by chemical synapses. In case of the expiratory motoneurons it appear that the oscillatory membrane potential is similarly produced by excitatory and inhibitory synaptic inputs but with an reverse phase. Electrical stimulation of the lateral nerve, nlA, evoked a depolarizing response in the expiratory motoneurons and a hyperpolarizing response in the inspiratory motoneurons.

7P,18 OLFACTIORY RESPONSE OF THE MOTH SPODOPTERA LITTORALIS TO VOLATILE FRACTIONS OF ITS HOST PLANTS,

Rizk, A., Khalifa, A., Salama, H. and Sharaby, A. (National Research Centre, Dokki, Cairo)

The structure and innervation of olfactory receptors of the moth Spodoptera littoralis are described. The moth response was tested to 55 volatile oils that occur in the flowers and leaves of its host plants. Iso-eugenol, geraneol, farnesol, borneol, citronellol, linalool, humuline, limonene, α-pinene, β-pinene, caryophyllene oxide and citral purifi were attractive to both sexes. Some other oils were attractive to the female moths but not to the males and vice versa, which indicate the high specific function of receptors. The volatile fraction of Gossypium, barbadense (the most favourable host plant) was highly attractive to the moths. The components of this fraction as identified by combination of TLC and GLC techniques were citronellol, 2-phenyl ethanol, α-pinene, α-bisabolol, β-caryophyllene oxide, α-terpineol, camphene, copaene, borneol, iso-borneol, pentanol, benzyl alcohol and (-) S-cadenine.

7P,19 COURTSHIP BEHAVIOR OF JAPANESE SCORPION FLY, PANORPA JAPONICA THUMBERG.

Okui, K., Nakagoshi, M. and Saikawa, M. (Biol. Lab., Kitasato Univ., Sagamihara, 228 Japan)

The female of the Japanese scorpion fly, Panorpa japonica THUMBERG, sucks food in copulation. Food serves as a suitable place for the encounter between the male and the female. In most cases it is in the afternoon that an individual becomes active in the bushes and searches for food. Immediatly after getting food, it starts feeding. It has been observed that when an individual meets with another, both respond and approach each other slowly, wings moving gently. When the encounter between the male and the female occurs on the food they have got, the male moves up to the female. Mating is usually seen while the female is sucking food, but it gets interrupted when the female suspends feeding. When a male individual meets with another of the sex, fighting occurs. Our observation shows that mating usually occurs a few days after emergence. There seems to be a close relationship between feeding and the development of the ovum, but no convincing evidence has been advanced to show why the female sucks food in copulation.

7P,20 MATING BEHAVIOR OF THE POTATO TUBER MOTH, PHTHORIMAEA OPERCULELLA.

Ono, T. (Lab. Biol., Kinjo Gakuin Univ., Nagoya, 463 Japan)

Mating behavior of the potato tuber moth, Phthorimaea operculella, was examined from an ethological view point. The behavior is composed of several behavioral components, i.e. the release of the sex pheromone by female (calling), the approach flight and the search walk of male to the calling female, the hair brush display by male (not always essential), the copulation attempt of male to female.

The chief attention in this experiment was focussed upon the releaser of the male's copulation attempt. As a result, the copulation attempt was released by the mechanical stimuli resulting from male's contact with wing scales of female moths.

We will, moreover, discuss the role of each of two pheromone components which have been identified in this species (Roelofs et al., 1975; Yamaoka et al., 1976; Persoons et al., 1976) in an approach process of male to female.

7P,21

PHEROMONE GLANDS OF THE PARASITIC WASPS, GENUS *APANTELES*.

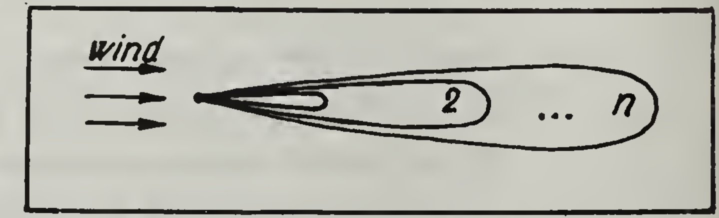
Tagawa, J. (Dept. Zool., Kyoto Univ., Kyoto, 606 Japan)

Many authors have located female sex pheromone glands in the Hymenoptera; e.g., at the anterolateral margins between the 2nd and the 3rd abdominal segments in a pine saw-fly, and the mandibular glands in the honey bee. In the parasitic Hymenoptera, however, few works have been reported on the localization of the glands. In *Campoletis sonorensis*, pheromone is supposed to be produced over the whole body (Vinson, 1972), and in *Apanteles glomeratus*, the pheromone glands seem to be located near the ovipositor (Obara and Kitano, 1974). The histological studies revealed that female *A. glomeratus* possesses a pair of secreting glands in the tip of the abdomen, at the base of the 2nd valvifer (Tagawa, 1977). The wasps of other species of the genus *Apanteles* investigated were found to have similar glands like those of *A. glomeratus*, locating in the same region, and here are tiny pores which seemed to secrete the pheromones. This appeares to be the general pattern in all the *Apanteles* group.

7P,22

SPATIAL STRUCTURE OF MULTICOMPOUND PHEROMONE SIGNAL.

Būda V. (Inst. Zool. and Parasitol., Lithuanian Acad. Sci., Poželos 54, Vilnius, USSR)



Under natural conditions plume of pheromone emitted into the air is formed. Parameters of its effective with the pheromone concentration above the response threshold, depends on the ratio Q/K. Q is the rate of pheromone emission, K is the threshold for pheromone-responsiveness (Wright, 1958, Bossert, Wilson, 1963). Most insect species use multicompound pheromones. So, it appears likely that for any given component or at least for several of the whole mixture, the ratio Q/K is not the same. Thus, the odour plume will have a multilayer structure (fig.). Such a system is more resistent to noise than that of a single component. Thus it can function more successfully with population densities being higher. Air permeation with a single component will lead to a partial disruption of pheromone communication only.

7P,23

HAREM FORMATION OF THE WINTER CHERRY BUG

Fujisaki, k. (Okinawa Pref. Agri. Exp. Stn., Sakiyama-cho, Naha, 903 Japan)

The winter cherry bug, *Acanthocoris sordidus*, is a pest of the crops of Solanaceae and Convolvulaceae in Japan. It was found that this plant bug forms a harem on the host plant during the long breeding season. That is, on a host plant, a single male usually monopolizes several females and copulates with them in turn. Males establish a small territory around the colony of females and guard them from other males by threatening and actual combat. Threats consist of the defender aggressively charging the intruder and combat involves wrestling with the opponent using the spinose hind legs as a weapon. If threat fails to evict the intruder, combat usually ensues. However, in most cases, the harem owner can evict the challenger. Males abandon the territory within a day or so once the monopolized females have been obliged to move to unexploited plants by deterioration of the plant due to mass sucking. Like other animals which form a harem (e.g. many pinnipeds), the gregariousness of females seems to accelerate the direct monopolization of them by males. As females in aggregation are highly resident on a host plant as compared with a single female, such a harem formation is profitable for maximizing matings. Larger colony of females attract more males, which causes an intensive intra-sexual selection. As a result, the body size of harem owner is positively related to the harem size.

7P,24

DUAL PATTERN IN THE MATING BEHAVIOUR OF THE MANTID, *HUMBERTIELLA SIMILIS* G.T. (MANTODEA: MANTIDAE). Misra, S.L. and Sidhu, R.K. (Miss)
(Dept. Zool., Jodhpur Univ., Jodhpur,342001 India)

Considering the limitations the compound eyes impose on distant vision, the motivating stimulus of the mature male mantid, *Humbertiella similis* must be the female pheromone. But the cannibalistic female, on spotting the male from his movements at a distance, acts like a predator and the male the prey. The male is under two antagonistic urges - to escape the predator, at the same time also to mate with her. The escape for him is possible only when he becomes invisible to the female by becoming motionless (thanatosis). He is under the inhibition exercised by the suboesophageal ganglion (Rau & Rau 1913, Rabaud 1916 and Roeder 1953) but only so long as he is inching his way to a close enough distance from where he leaps onto her back. The female-contact keeps the inhibitory control suspended in the male so long as the contact lasts, releasing the copulatory reflexes. In the female, as soon as the male holds her ovipositor, her predatory behaviour changes in favour of cooperation which lasts till the oviporitor is held. As soon as it is released, after the copulation, the predatory-prey relationship is resumed. Of the 30 pairs studied, 22 succeeded in copulating, 4 were attacked and eaten up up as they neared her. One escaped the chase given by her and another one narrowly escaped from her back in a confusion, having failed to raise her abdomen.

Section 8.

Agricultural Entomology.

8S-1,1 FRUIT MOTH RESEARCH IN JAPAN.

ÔTAKE, A. (Fruit Tree Research Station, Yatabe, Tsukuba, Ibaraki, 305 Japan)

According to their modes of injury, Lepidoptera attacking tree fruits can be divided into the following 4 groups: (1) fruit borers such as Grapholitha molesta Busck, Carposina niponensis Walsingham, Dichocrocis punctiferalis Guenée and Kakivoria flavofasciata Nagano; (2) leaf rollers such as Adoxophyes orana fasciata Walsingham, which damage the surface of fruit when their density is high; (3) defoliators such as Lymantria dispar Linné, which actively feed on young fruits as well as leaves; and (4) fruit piercing moths, mainly noctuids such as Adris amurensis Staudinger and Oraesia excavata Butler. As examples of studies on these pests in Japan, the synthetic sex pheromone of Carposina niponensis, microbial control of Adoxophyes orana fasciata attacking apple and the species differentiation in Dichocrocis punctiferalis will be presented at the symposium.

8S-1,2 PEACH FRUIT MOTH, CARPOSINA NIPONENSIS WALSINGHAM (CARPOSINIDAE), WITH PARTICULAR REFERENCE TO THE ECOLOGY OF COCOON FORMATION AND GROUND SURFACE APPLICATION OF INSECTICIDES.

NARITA, H. (Akita Fruit-Tree Experiment Station, Hiraga, Akita, 019-05 Japan)

In Japan, Carposina niponensis is one of the most dangerous insect pests of apple. It also attacks peach, Japanese pear and some other kinds of tree fruits. C. niponensis overwinters underground at the final stage of larva. The cocoon made by the overwintering larva is called a "winter cocoon". After the completion of the overwintering diapause, the larva leaves the cocoon, moves upwards and again spins another cocoon, the "summer cocoon", to pupate in close proximity to the surface of soil. In the northern part of Japan, the main area of apple growing, the species usually has 2 generations, being partially univoltine. Day length is believed to be most important for the induction of the overwintering diapause, the critical point being estimated to be between 14 and 15 hours. Chemical control of C. niponensis is usually done by the foliage application of organic phosphorous insecticides. In areas with a high density of the pest, ground surface application of insecticides such as diazinon granules is recommended along with the foliage treatment in order to prevent moth emergence.

8S-1,3 STUDIES ON ADOXOPHYES ORANA, THE MAJOR LEAF-ROLLER PEST IN APPLE ORCHARDS IN THE NETHERLANDS.

De Jong, D.J. and Minks, A.K. (Research Institute for Plant Protection, IPO, Wageningen, The Netherlands)

The summerfruit tortrix moth, Adoxophyes orana (Lepidoptera : Tortricidae) can be considered as the key-pest in Dutch apple orchards. In commercial orchards it is general practice to control the larvae of this moth species with broad-spectrum insecticides. Correct timing of the sprays is essential, because they are only sufficiently effective against newly emerged larvae in search for fresh leaves. Prediction of the timing is based on the heat summation method using phenological observations with sex pheromone traps on moths of the preceding generation and temperature recordings. This forecasting system plays a major role in our program of supervised control which is now in operation in approximately 25% of the orchards. The number of sprays is then reduced by half.

Introduction of an integrated control program into practice is much hampered by the fact that no insecticide is available for selective control of A. orana. Diflubenzuron is not active enough and the insect growth regulator, epofenonane, will not become commercially available, although it showed much promise. Therefore much attention is being given to the development of other methods of selective control e.g. parasites, baculoviruses and sex pheromones (mating disruption method).

8S-1,4

ILLUMINATION OF ORCHARDS AND VINEYARDS: AN EFFECTIVE MEASURE AGAINST FRUIT-PIERCING NOCTUID MOTHS.

UCHIDA, M. and ÔTAKE, A. (Tottori Fruit Tree Experiment Station, Daiei, Tôhaku, Tottori, 689-22 Japan)

In Japan, such tree fruits as citrus, Japanese pear, peach and grape are often seriously damaged by fruit-piercing noctuids, *Adris amurensis* Staudinger, *Oraesia excavata* Butler, *Lagoptera juno* Dalman, etc. These moths become active when their compound eyes adapt to darkness, and it is possible to convert the adaptation to darkness into adaptation to light by artificial illumination. So long as the compound eyes of a moth remain adapted to light, its flight activity is strongly inhibited and fruit piercing hardly takes place even at night. In this regard, yellow light was proved to be particularly effective, and illumination of orchards and vineyards by yellow colour lamps is widely practised now in Japan. By using 40 W bulbs of yellow fluorescent lamp, 7 bulbs per 10 a (=0.25 acre) are effective for Japanese pear and much sparser setting would be sufficient for citrus and grape.

8S-1,5

MANAGEMENT OF THE ORIENTAL FRUIT MOTH IN MICHIGAN WITH SYNTHETIC SEX PHEROMONE.

Croft, B. A. and R. T. Cardé (Dept. Ent., Pest. Res. Ctr., Mich. St. Univ., E. Lansing, MI 48824

Management of the Oriental Fruit Moth, *Grapholitha molesta* (OFM) with synthetic sex pheromone has been evaluated in the field: 1) using moth catch in baited traps as biological fixpoints in phenological models which time sampling and application of control tactics and 2) for direct control [illegible] by disrupting male attraction and thus preventing mating. Studies have shown pheromone trap catch during spring emergence to be highly correlated with actual emergence of male moths. In pheromone-timing experiments based on 8 years field data, phenological models were +2 ± 6.1 degree days and +0.8 ± 32.8 or on the average *ca*. +0.3 ± 1.5 days late in predicting 50% adult emergence in spring and the first summer generation. As little as 2.5×10^{-4} g/ha/day of the (*Z*)- and (*E*)-8-dodecenyl acetates was effective in disrupting male attraction. Addition of (*Z*)-8-dodecen-1-ol, another pheromone component, to the acetates elevated the disruptive effect of the blend. A rate of 2.5×10^{-3} g/ha/day of acetates alone effects 99% disruption of attraction to synthetic lures or females.

8S-1,6

MANAGEMENT OF THE CODLING MOTH, *LASPEYRESIA POMONELLA* (L.) ON APPLE AND PEAR.

Madsen, H.F. (Agr. Can. Res. Sta. Summerland, B.C. Canada)

In British Columbia apple orchards and in apple and pear orchards in the western United States, sex pheromone traps are used to monitor codling moth populations and determine the need for and timing of control measures. Trap density and treatment threshold varies with the area and must be locally determined. In B.C., traps are deployed at a density of 1 per ha and a treatment level is an average of 2 moths per trap in 2 consecutive weeks. Because orchards are relatively small in B.C., traps must be placed in neighboring orchards to minimize immigration from this source. Azinphos-methyl, phosalone and phosmet are the preferred chemicals for codling moth control because they are less disruptive in integrated pest management programs.

8S-1,7 *TRICHOGRAMMA FUNICULATUM* AS AN EGG PARASITOID OF *EPIPHYAS POSTVITTANA* (LEP.:TORTRICIDAE) AND ITS BIOLOGICAL CONTROL POTENTIAL.

Danthanarayana,W.,Zoology Dept.,La Trobe Univ.,Vic.,Aust.,3083.

Host-parasitoid interactions of the tortricid *Epiphyas postvittana* (Wlk.) and its egg parasite *Trichogramma (Trichogrammanza) funiculatum* Carver in Australia was studied for 17 and 10 generations at two study sites between 1971 and 1977. Inter-generation parasitism ranged from 0-43.3% with high levels of parasitism of spring generation eggs in January-March, a low level of parasitism of winter generation eggs in October-December and no parasitism of summer generation eggs in May-June. Since *E. postvittana* overwinters as larvae in winter, *T. funiculatum* is deprived of host eggs during June to September. A delayed direct (density-dependent) relationship was found to exist between this host and the parasitoid. The value of these findings in possible inundative release of *T. funiculatum* for biological control of *Epiphyas postvittana* is discussed.

8S-2,8 BOUNDARY OF CHEMICAL RICE INSECT CONTROL AND THE NEED FOR RECONSTURCTION OF INTEGRATED CONTROL.

Ishikura, H. (Inst. Env. Toxic., Kodaira, Tokyo, 187 Japan)

Before the advent of chemical control in early 1950s, rice insect pest control in Japan had been mainly cultural and partly physical and biological. It was of an integrated form to some extent. However, those methods of cultural control such as delayed transplanting, sparse spacing and fertilization at lower level had been the constraints to the increase of yield of rice. Development of effective chemical control measures and its extensive introduction removed these constraints and the yield of rice started to step up remarkably since middle 1950s.

Rice insect pests having one or two generations annually almost disappeared or were suppressed to a low level by the introduction of chemical control. However, those pests such as leaf- and planthoppers built up their population to a level which called for frequent application of pesticide for their control due to the reduction of biological controlling agent and to the change in cultural practice of the adoption of early transplanting, denser spacing and heavier fertilization. Repeated application of pesticides for their control induced also the development of insect resistance to pesticides which made the chemical control less effective.

In order to overcome these problems and in order to reduce the production cost of rice by decreasing the application of pesticides, integrated control of rice insect pest should be sought and reconstructed.

8S-2,9 SCOPE OF RICE AND INTENSITY OF PEST PROBLEMS IN TROPICAL ASIA

M. D. Pathak and G. S. Dhaliwal (The Int. Rice Rec. Inst., P.O. Box 933, Manila, Phil.)

About sixty percent of the world's total rice area is in tropical Asia where population densities are high, landholdings and per capita income are small and usually rice production per unit is low. There is little scope for bringing additional land under cultivation. So, much of the increase in rice production has to come by increase in yield/ha and cropping intensity. The increase in production would be larger in irrigated areas.

Rice pests abound the warm and humid rice fields in tropics but their problem is apparently more intense in fields with thick crop stand and high cropping intensity. Thus, in future the insect problem is likely to become more intense, and the change in rice plant type is expected to bring about shift in relative status of different pest species. Such changes are becoming apparent but are also greatly influenced by the varietal resistance to insect pests, agronomic practices and adoption of integrated methods of pest control.

8S-2,10 TRENDS OF RICE INSECT-BORNE VIRUS DISEASES IN TROPICAL ASIA. Inoue, H. (Kyushu Nat. Agric. Expt. Stn., Chikugo, Fukuoka, 833 Japan)

Intensive studies on rice virus diseases in tropical and subtropical Asian countries have been in progress only for the past 20 years, and 8 insect-borne virus and MLO diseases have been found. Of these diseases, the green rice leafhopper-and zigzag leafhopper-borne tungro, the brown planthopper-borne grassy stunt and ragged stunt are economically the most important.

In 1968 or 1969 the tungro had reached epidemic proportions in most of the tropical countries after the introduction of modern rice cultivation technology since 1965 - 1969. The disease incidence has shown to correlate with population build up of its major vector, *Nephotettix virescens* during the epidemic period, however, the disease has occurred sporadically in recent years. Afterwards, the rice grassy stunt increased since 1971 - 1974 in Indonesia, Philippines and India because the vector brown planthopper became prevalent during the past decade. After 1978 the rice ragged stunt, a newly-found disease, became more severe in Indonesia and Philippines, and the disease is going to spread widely with the high incidence of the vector population all over tropical Asia.

8S-2,12 'THE ROLE OF INTEGRATED PEST MANAGEMENT IN GREEN REVOLUTION IN INDIA'.

Kulshrestha, J.P. (Central Rice Research Institute,Cuttack,India)

Rice is grown on 38 million ha. in India. The total production of paddy (rough rice) has steadily increased from 45.6 million T. in 1962 to 70.5 million T. in 1975 and continue to increase further. Integrated management of rice pests has greatly contributed to this increase. An individual rice farmer manages his crop pests in India. He is assisted by Central and state agencies and Agril. Universities who forewarn him about pest attack and advice control measures. Special Integrated pest management programmes are also in operation in 5 states in 6 pest endemic locations. Use of gall midge and BPH resistant varieties, constant monitoring of pests, their parasites and predator populations, use of insecticides based on economic thresholds are the main components of these programmes. The programmes have brought about 50 to 75% reduction in use of pesticides as compared to the (base year 1975) increasing the grain yields at the same time. Losses due to stem borers and gall midge have been reduced and spread and losses caused by Brown Plant hopper(*Nilaparvata lugens*) have been checked.

8S-2,13 THE ROLE OF INTEGRATED PEST MANAGEMENT IN THE GREEN REVOLUTION IN INDONESIA.

M. Soehardjan, Central Research Institute for Agriculture, Bogor, Indonesia.

The green revolution refers to the intensive use of technological inputs for increasing rice production. A principal input was the use of high yielding rice varieties. Under intensive input, rice pests were more severe along with a shift in importance of insect species. Brown planthopper replaced stemborers as the major pest. Brown planthopper significantly reduced and distabilized rice yields. However, minor pests cannot be ignored as they may become major pests. The composition of rice pest populations varied at different locations, demonstrating that integrated pest management should be site specific.

8S-2,14

THE ROLE OF INTEGRATED PEST MANAGEMENT IN THE GREEN REVOLUTION IN THAILAND. T. Wongsiri and C. Tirawat

Integrated pest control with the pesticides is still the most important control in Thailand. The resistant varieties, time of transplanting, pest surveillance and only one application of insecticide after reached the estimated economic threshold give the most effective control of the rice gall midge, Orseolia oryzae in the north and north-eastern Thailand.

In the central plains, where the brown planthopper, Nilaparvata lugens plays the most important role. Moderate resistant varieties, cultural control practice, pest surveillance and pesticides applications have been used as needed base on estimated economic threshold in order to maximize the use of natural control agents can increase the yield up to 26.25% which is more than the use of insecticides alone.

8S-3,15

AGRONOMIC AND CHEMICAL CONTROL OF RICE SEEDLING FLY (ATHERIGONA EXIGUA STEIN) ON CORN IN EAST JAWA. Chu, Yau-i (Dept. of Plantpathol. & Ent., Nat. Taiwan Univ., Taipei, Taiwan)

Rice seedling fly (Atherigona exigua) is an important insect pest during the early growing stage of corn in Indonesia, especially at East Jawa. Corn seedlings of 1 to 7 days old were found to be the ovipositional substrate for the fly. Seedlings of more than 10 days old did not have the possiblity to become the ovipositional attack target. The attack becomes active with the beginning of the rainy season. In this duration percent of damage frequently zoomed up more than 90 percent.

The experiment of chemical control was conducted with 50% diazinone and 50% sumithion E. C.. The application of both insecticides showed excellent control effect. The advisable concentration is 0.5 ml E. C. per 1 liter water. The higher dosage of insecticide is not demanded. A application of diazinone is preferable to be conducted on the 2nd day of corn germination. But single treatment cannot cover whole the damaging period of corn. The second treatment should be done on the 3rd day of the 1st application. In the case of epidemic or long spelled ovipositional attack, the 3rd application is demanded on the additional 3 days.

The intercropping of corn with paddy plant is conducted. Then corn is sowed two weeks before the harvest of paddy. The result of intercropping indicated the obvious protective effect of corn from the ovipositional attack. The percent of damaged seedling is under 20% in the worst case. The occurence of the damaged seedling is restricted in the border area of 1.4 m width zone from the foot path.

8S-3,16

MANAGEMENT OF SUGARCANE INSECT PESTS IN TAIWAN. Pan, Y. S.(Dept. Plant Protection, Taiwan Sugar Res. Inst., Taiwan)

About 100,000 ha of sugarcane are harvested every year in Taiwan, and the sugar production amounts to an average of 800,000 tons/year. Although 28 species of insect pests have been commonly found in sugarcane fields, 7 species are considered to be the major pests. Chemical control of the major pests except the sugarcane woolly aphid, Ceratovacuna lanigera, white grubs and wireworms, has been found to be impractical. The population of Matsumuratettix hiroglyphicus declines rapidly during December-April, resulting in low incidence of white leaf disease on spring cane. Thus, spring planting of sugarcane has been practiced to prevent transmission of the disease by the vector. Periodical release of Trichogramma australicum has resulted in lower degrees of larval infestations of Argyroploce schistaceana, Proceras venosatus and Chilotraea infuscatella on young plants and the internodes of cane stalks. The parasite is mass-produced in each sugar mill and released into fields at a rate of 10,500/ha during a period of 7-10 months every year. Sugarcane seedling evaluation was applied for screening sugarcane germ plasm for resistance to A. schistaceana. Release of Isaria sinclairri in the soil resulted in considerable increase in percent parasitism of Mogannia hebes nymphs causing depressed germination in ratoon. Economic thresholds were established for the sugarcane white grub, Alissonotum impressicolle, and the wireworm, Melanotus tamsuyensis. Preplanting application of Thimet, Terracur P and Counter granules at the rate of 3 kga.i./ha has been recommended to replace aldrin and heptachlor for the control of these insects. Deep plowing of the soil after harvest of sugarcane and growing of paddy rice in the severely infested fields also play an important role in soil insect control. Studies are underway to improve application methods of the non-persistent insecticides, and also to develop integrated management program for the important soil insects.

8S-3,17 LIFE HISTORY OF OIL PALM NETTLE CATERPILLARS IN SABAH, MALAYSIA

Abe,N.(Tropic. Agric. Res. Center,Japan) and Tay,E.B.(Dept.Agric, Sabah,Malaysia)

Nine Species of nettle caterpillars of oil palm have been reported in Sabah. All of them attack the leaf of oil palm and some of them attack coconut palm and sago palm too. Although these caterpillars are found commonly in the oil palm fields, their life history has remained unknown so far owing to the heavy mortality of larvae raised in the laboratory. The authors succeeded in developin a method enabling to raise the larvae of nettle caterpillars with low mortality in the laboratoy by using a special metal case in which high humidity conditions similar th those in the field could be achieved.

The life history of the following specoes pf nett;e caterpillars *Darna trima* Moore. *Thosea asigna* Moore, *Thosea vetusta* Wlk., *Thosea bisura* Moore. *Setora nitens* Wlk., *Birthamula chara* Swinh., *Macroplectra* sp. was recorded.

8S-3,18 Maintenance and Improvement of An Ongoing Sugarcane Insect Pest Management Program.

Hensley, S.D. (U.S. Sugarcane Field Laboratory, Houma, LA, USA)

An integrated multiple tactic management strategy for control of sugarcane insect pests in Louisiana was initiated in 1963 after over-reliance on organochlorine insecticides had caused serious pesticide-related ecosystem disruptions and triggered intense insecticide resistance in populations of the key crop pest, *Diatraea saccharalis* (F.). More emphasis on host (cultivar) resistance, arthropod predators and cultural control practices as worthwhile pest suppression tactics plus development of reliable economic population thresholds and adequate field surveillance has led to a drastic reduction in the amount of insecticide required annually for control of sugarcane insects in Louisiana. No further problems with insecticide resistance have been experienced and the detrimental effects of insecticides on the environment and beneficial non-target organisms have been minimized. The problems encountered in developing and maintaining this pest management program plus the significant research responsible for its success are discussed.

8S-3,19 INTEGRATED LOCUST CONTROL IN CORN FIELD IN THAILAND

Mongkolkiti,S.,Wongsiri,T.,Phitak,C.,and Visetsan,S.(Department of Agriculture,Thailand)

In1978,several aspects of locust and grasshopper ecology have been investigated both in laboratory and field conditions of Si Sa Ket province . Grasshoppers in the field were found frozen at below 10° c and became infected with the fungus, *Entomophthora grylli* by the temperature below 24° c and the humidity above 70 % in the rainy season. In 1980, more than 80 tons of adult insects were caught in grasshopper catching race. In order to protect natural enemies of grasshoppers, it has not been allowed to use any contact insecticide in the growing season. After avoiding the contact insecticides, it was found that the population of the egg parasites, *Scelio facialis* and the predaters, the grubs of the oil beetles to increase immediately. Intercropping between corn and soybean has created conditions favoring the grasshoppers to take soybean as their shelters when the temperature was so high. This was the weak point that the insects could be eliminated easily either by insecticide spraying or duck grazing. Caging adult grasshoppers in the areas where contact insecticides have not been used and then the collecting the parasitized egg pods and releasing the emerged parasites in the grasshopper outbreak areas would also increase the *Scelio facialis* population. By all of these procedures, it was found at the beginning of 1980 that the outbreak of the hoppers completely stopped.

8S-4,20 REVIEW: SIRM WITH SPECIAL REFERENCE TO QUALITY CONTROL.

Chambers, D. L. (Insect Attractants Lab., USDA/SEA/AR, Gainesville, FL 32604 USA)

Concepts, philosophies, and technologies for obtaining control of the quality of fruit flies mass-reared for the SIT have progressed rapidly in recent years. This progression will be discussed with emphasis on the present state-of-the-art in production of the Mediterranean fruit fly. The similarity of needs for quality control in fruit fly production to those needs in industry at large will be discussed with reference to industrial approaches to quantitative analysis.

8S-4,21 FRUIT FLY QUALITY MONITORING. Chambers, D. L., and Agee, H. R. (Insect Attractants Lab. USDA/SEA/AR, Gainesville, FL 32604 USA)

The electroretinografic method for measuring visual sensitivity of the compound eye has been used for assaying quality (visual sensitivity) of the medfly, Caribbean fruit fly, and screwworm fly. Wild medflies from Hawaii and Costa Rica had equal sensitivity. Hawaiian laboratory rearing techniques produced medflies with only a slight decline in visual sensitivity which was within the "normal" range of sensitivity of the wild fly. All strains of laboratory-reared medflies receiving sterilizing doses of irradiation had reduced visual sensitivities when compared to the untreated laboratory-reared controls. Certain rearing systems produced medflies with significantly lower visual sensitivity than the Hawaiian laboratory-reared medfly. Also, certain pupal handling procedures and high temperatures had additional negative effects on the quality (visual sensitivity) of the medfly. Transmission electron microscopic studies of the cellular structure of the ommatidia of wild, laboratory-reared, and irradiated laboratory-reared medflies explain the low quality (visual sensitivity) and support the use of the ERG method for quality monitoring of mass-reared fruit flies. Rhabdomeres of the laboratory-reared medflies were somewhat smaller than the wild flies. Ommatidia of medflies receiving sterilizing doses of irradiation had additional negative changes at the subcellular level. The value of the electroretinografic method for quality monitoring of the mass-reared medfly will be discussed.

8S-4,22 SIRM AGAINST DACUS OLEAE: 1) PRODUCTION, STERILIZATION, QUALITY,2) PROSPECTS FOR LARGE SCALE APPLICATIONS. Economopoulos A. ("Demokritos" Nuclear Research Center, Aghia Paraskevi Attiki, Greece).

The production cost of artificially reared Dacus oleae (Gmelin) (Diptera, Tephritidae) has been estimated at ca. \$ 0.6/1000 pupae. Certain problems are still to be solved in order to achieve a standard production of large numbers of good quality insects over long periods. So far, releases up to ca. 1/2 million flies/week have been used in SIRM applications. Pupal sterilization at 11 Krads of Co^{60} gamma rays in nitrogen produces high sterility in both sexes. Sterilized males are highly competitive when lab and wild insects are mixed in lab cages. Lab flies were found to undergo considerable genetical, behavioral and physiological changes, even within few only generations of artificial rearing. So far, no prohibitive (for SIRM) change was detected. It should be noted, however, that not all quality tests have been verified in the field yet (e.g. mating competitiveness). Geographical isolation seems critical since the fly, especially the wild one, is capable for long flights.

8S-4,23 Qualitative change in the mass reared melon fly, Dacus cucurbitae COQ.

Kakinohana, H. (Okinawa Pref. Agric. Exp. Sta., Sakiyama-cho, Naha, 903 Japan)

The larvae of the melon fly, Dacus cucurbitae COQUILLTT, were collected from infested fruit and introduced into the laboratory culture in 1972. This culture was maintained for 13 generations until May, 1974 and reared under mass rearing condition from then through November, 1979, for about 44 generations. The ability of oviposition, mating and flight, and amount of CO_2 output were compared between the laboratory rearing (L) strain and the wild (W) strain. As compared with the W strain, the L strain had earlier sexual maturation, that is, earlier and higher mating frequency and ovipositing ability. The mating of flies occurred basically at dusk in both the strains, but starting time of mating was a little earlier in the L strain than the W strain. A similar trend as starting time of mating was seen in the peak of CO_2 output in both the strains. In the Mating competitiveness test with three size cages, males of L strain surpass that of the W strain in the narrower two cages, but in a large cage, the competitiveness of W strain was nearly same as that of the L strain. Dispersal ability and longevity were compared between both the strains under the field conditions. Dispersal rate of the L strain at 23 generations after colonization was same as that of the W strain. However, the L strain at over 40 generations from colonization showed not only less dispersal ability but also less longevity than the W strain. These results suggest that some qualitative deteriorations had been occurred in the L strain as a result of long term successive mass rearing. Therefor, we should introduce new wild flies into mass rearing program at a certain interval.

8S-4,24 Analysis of Mating Behavior of Frugivorous Tephritidae in Nature

Prokopy, R.J. (Dept. Ent., Univ. Mass., Amherst, Mass. USA)

Analysis of the mating behavior of several Rhagoletis species and Ceratitis capitata under natural or semi-natural conditions reveals that mating is initiated predominantly or exclusively on the larval host plant. In Rhagoletis, mating encounters occur on the leaves of host plants early in the fly season but shift to the fruit with the onset of oviposition. In C. capitata, the males, which form leks on host foliage at mid-day, shift mating activities to host fruit later in the day. The principal strategy of the males visiting host fruit appears to be maximization of the opportunity of seducing or raping already-mated or otherwise unreceptive females exhibiting little or no attraction to sex pheromone emitted by males on leaves. Confinement of mating to a particular rendezvous site such as the host plant may be extremely important in ensuring pre-copulatory reproductive isolation. Combined findings suggest that success of current programs aimed at tephritid fly suppression through release of sterile males may be intimately dependent upon the ability of the released males to readily locate the mating rendezvous site characteristic of its species, and in some species, to readily form leks attractive to native virgin females.

8S-4,25 GENETIC STUDIES OF TEPHRITID FLIES IN RELATION TO THEIR CONTROL

Wood, R.J. (Dept. Zool., Manchester Univ., M13 9PL, U.K.

The suitability of tephritid fruitflies as genetic subject will be discussed, and a summary given of the present state of genetical knowledge of this family. The value of genetical studies will be considered particularly in relation to the "quality control" of mass reared colonies and to the development of inherited sex-separating techniques.

8S-4,26 RESPONSES OF MEDITERRANEAN FRUIT FLY CERATITIS CAPITATA TO AMINO ACIDS.

Galun, R., Nitzan, Y., Blondhein, C. and Gothilf, S. (Dept. Zool. Hebrew University, Jerusalem, Israel)

In 2-choice experiments, Mediterranean fruit flies of both sexes and of all ages preferred a combination of sucrose and casein hydrolyzate to sucrose alone. When used in place of casein hydrolyzate under the same experimental conditions, some individual amino acids in combination with sucrose were also preferred to sucrose alone. Not all of these amino acids were identical to those shown to stimulate the sugar receptors of the blowfly. In fact, some of the amino acids which were shown to inhibit all labellar receptor cells of Phormia, stimulated feeding by Ceratitis.

Assuming that phagostimulation by both sucrose and amino acids is effected through the same sugar receptor cells, there is some evidence from intensity discrimination tests, that amino acids may produce greater stimulation than sucrose.

8S-5,27 SOYBEAN COMMUNITY ORGANIZATION.

Price, P. W. (Mus. N. Arizona, Flagstaff, Arizona, 86001, U.S.A.)

The community of organisms on soybeans develops through colonization by herbivores and their enemies during each growing season. The factors favoring herbivore colonization are discussed and are contrasted with the factors most conducive to their enemies. Management practices to improve colonization and maintenance of enemies are discussed. Colonization may be by generalists that transfer rapidly to a newly introduced crop, with the slower colonization of specialists from related and unrelated plant species over many seasons, and probably involving the evolution of a new host race on the new crop in some cases. These processes seem to occur rapidly since there is no evidence that the richness of species on soybeans is poorer in regions where it is an exotic plant than where it is indigenous.

8S-5,28 SOYBEAN DEFENSES AGAINST HERBIVOROUS ARTHROPODS.

Kogan, M. (Ag. Ent., Univ. of Illinois, Urbana, IL 61801, USA)

Soybean is optimally adapted to growth under temperate zone conditions. Within a latitudinal band in which the crop cycle is completed in 100-120 days a combination of ecological and plant factors allow a remarkable display of defense mechanisms that greatly dampen the impact of potentially damaging herbivore pests.

Most recognized mechanisms of ecological and genetic resistance operate at various stages of plant growth. Rapid seed germination and quick maturation permite escape from seed and seedling pests early in the season and pod feeding pests late in the season. Leaf pubescence is an outstanding defense against leafhoppers and other small sucking insects. Leaf chemistry is probably rich in allomones that affect both the metabolism (antibiosis) and the behavior (antixenosis) of phytophagous arthropods. Seeds are protected by a powerful allomonal repertoire including proteinase inhibitors and saponins. Finally the plant is remarkably tolerant to stand thinning, defoliation and depodding. With incorporation of these various components of resistance it is conceivable that cropping systems can be designed to maximize expression of these traits thus virtually eliminating the impact of herbivores throughout extensive areas of cultivation.

8S-5,29

PREDATOR-PREY INTERACTIONS IN SOYBEAN COMMUNITIES: IMPLICATIONS OF PESTICIDE PERTURBATIONS. Kobayashi, T. and Oku, T. (Upland Crop Farm. Res. Cent., Cent. Agr. Expt. Stan., Tsukuba, 305 Japan)

There inhabit about 140 species of arthropods in soybean fields in the Tohoku district of Japan. In the soybean community, soybean pests, predators and parasites occupy about 29 %, 38 % and 11 % of the whole arthropod association. Among the predacious arthropods in soybean fields at Morioka, Phytoseiid mites, Amblyseius spp., and Anthocorid bugs, Orius sp., usually predominate. The former prey upon Tetranychid mites, and the latter prey upon aphids and thripses as well as Tetranychid mites. The predators are first found in the fields at the end of June, and the peak period of their activity usually spannes from early July to mid or late September. Effect of their activity on the prey populations is varied in accordance with the relative abundance of these predators and preys. A pesticide application at the end of July or the beginning of August causes a prolonged suppression of the predator populations and induces a conspicuous increase of prey populations. The results are correlated to different seasonal cycles of the predators and the preys.

8S-5,30

ECOLOGY OF VIRUS SPREAD IN SOYBEAN ECOSYSTEMS. Irwin, M. (Ag. Ent., Univ. of Illinois, Urbana, IL 61801, USA).

Soybean viruses abound in many parts of the world, several of which cause severe economic losses. All known soybean viruses are transmitted within and among soybean fields by insect and/or nematode vectors. Dynamics of virus epidemiology depend on several factors, the following of which seem most important: virus association with plant hosts and with vector hosts, alternate plant hosts for virus and vector, mode of virus transmission and vector species, soybean cultivar and relative resistance to vector and/or virus infection, virus type and strain, primary inoculum sources, seed-borne potential of virus in soybean and in other host plants in and near the ecosystem, and spatial and temporal movement patterns and colonization potential of vectors relative to soybean growth types. Choice of management tactics available to delay or limit virus spread depend on the resolution of the above factors. Several examples will be used to emphasize differences in virus epidemiology and differences in employment of management tactics.

8S-5,31

THE ECOLOGY OF SOYBEAN INSECT PEST MANAGEMENT. Rabb, R. L. (Dept. Entomol., NCSU, Raleigh, NC 27650

Space-time arenas (fields) of species in a pest complex vary widely in size, and result in ecological constraints on the minimum size of practical management systems. If preventive tactics involving resource, natural enemy and habitat manipulations are to be used, the dimensions of the target areas must coincide with the fields of the pests. Integration of tactics varying in target size is a significant IPM problem, involving integration at several management levels (fields, farms, regions, etc.). Resource field integration and interactions among tactical inputs are discussed, with examples from contrasting soybean production systems.

8R-1,1 A CHARACTERISTIC OF DAMAGE OF LOQUAT FRUIT TREE CAUSED BY PLATYPLEURA KAEMPFERI (FABRICIUS) (HOMOPTERA : CICADIDAE) ADULTS.

Uematsu, S. and Onogi.S. (Chiba Hort. Exp. Station, Yamamoto, Tateyama, Chiba-ken, 294 Japan)

In Chiba prefecture, it is observed that P. kaempferi adults feed on the sap from loquat fruit tree tranks in crowds. When a loquat fruit tree was heavily attacked by the cicadas, the trank of the tree became wet due to continual effluence of tree sap from holes where cicadas inserted their stylets. This condition provided a good chance for the spreading of sooty mold and die-back disease of the tree. Heavily infested trees were also apt to be attacked by Xyleborus saxeseni (Ratzeburg) and Grapholitha molesta Busck. Spraying of NAC against the cicada was effective to prevent these infestations.

8R-1,2 ANALYSIS OF THE INJURY CAUSED BY THE JAPANESE CITRUS FLOWER-BUD MIDGE

Kato, T. (Yamaguchi Agr. Expt. Sta., Ooshima Citrus Br.)

The Japanese citrus flower-bud midge, Contarinia okadai (Miyoshi) is known as the pest which attacks the buds of citrus crops in the south-western area of Japan. Females lay eggs in flower buds. As the result of larval feeding on the pistils, stamens and petals within the buds the flowers become deformed through the course of development and fall down in the state remaining closed. The falling of the flower-bud is just the damage caused by this midge. Though a few of buds attacked in late developmental stage sometimes come into bloom the scarred immature fruits finally drop towards the end of June during the time of physiological fruit dropping.

The investigations on the bud falling arising from the infestation with the midge were conducted in the alternate bearing Satsuma mandarine trees. The influence of this injury on the yield of fruits and on the alternate bearing habit of the tree was different in various degrees with the flower bearing conditions. The damage brought about in the tree bearing too small number of flowers caused not only a yield loss of the current year but the excessive bearing of flowers in the following year as the result of more reduction in the ratio of fruit to leaves. On the other hand the damage in the tree bearing the excessive flowers reduced the number of flowers and brought down the rate of fruit to leaves towards the desirable level corresponding to 25 leaves per fruit.

8R-1,3 EFFECTS OF DELAYING RELEASE ON THE REPRODUCTION OF OSMIA (OSMIA) CORNIFRONS (RADOSZKOWSKI) IN APPLE ORCHARDS.

Maeta, Y. and Kitamura, T. (Ent. Lab., Tohoku Natl. Agric. Exp. Stn., Morioka, 020-01 Japan)

Several devoted farmers in Aomori Pref. first began to use O. cornifrons for the pollination of apples from 1950. The more widespread adoption of this pollinator has been affected by the development of managing techniques. Poor propagation of bees in apple orchards is inhibiting higher levels of utilization. The causes are both injury of application of hazardous insecticides and flower dearth at the pre-blooming period of apples. During 5 years' experimentation we found that delaying release was a favourable method of increasing the bee population within the limited blooming period of apples. The cocoons were stored at 5°C untill release. It is very important, but difficult to decide the best date for release. We found release of the bees at full blooming of cherries resulted in the fittest starting date for nidification of Osmia on the later flowering apples. By adoption of the delayed release the percentage of establishment (No. of established females/No. of released females X 100) reached as much as 80% and the average number of females produced by one nesting bee (No. of female cells/ Maximum no. of nesting bees at the season) as high as 6.8.

8R-1,4 BIOLOGY OF THE ORCHID WEEVIL, ORCHIDOPHILUS ATERRIMUS WATERHOUSE, IN HAWAII.

Mau, R. (Dept. Ent., Univ. Hawaii, Honolulu, Hawaii, 96822, USA).

Orchidophilus aterrimus Waterhouse is a weevil pest of Vanda, Dendrobium, and Phalaenopsis orchids in Hawaii. Development of all immature stages occur within orchid stems. Adults feed primarily on leaves and stems. Eggs are deposited within cavities created by adult feeding and hatch in an average of 11.3 days. There are 5-6 larval instars. Pupation occurs inside a cell within the gallery created by the larva. The pupal stadium averages 15.9 days. After eclosion adults do not feed for ca. 10 days. They escape from the gallery by chewing a hole in the stem. Males are larger than females. Females are not parthenogenic. A 47 day preoviposition period was observed. Females laid an average of 2.4 eggs per week during their lifespan. Eggs from females of various ages were very fertile; egg hatch exceeded 88%. Adults were long lived; 50% lived for 34-37 weeks and 8% longer than a year. Most of the feeding and and oviposition activity occurred during daylight hours.

8R-2,5 THE BIOLOGY AND LIFE CYCLE OF THE ORIENTAL STINK BUG, PLAUTIA STALI SCOTT.

Hata,K., Sato,H. and Imai,H. (Lab.Ent., Fac.Agri., Tokyo Univ. Agri. & Tech., Fuchu, 183 Japan)

The oriental stink bug, Plautia stali Scott, has recently become a serious pest of orchard. Field survey was conducted in Fuchu, Tokyo in 1979, as well as laboratory researches to make clear its biology and life cycle. The overwintering adults appeared on plum, mulberry, cherry, or Japan cypress in May, and ovipositions were found on these plants except Japan cypress. In summer and fall, a number of adults appeared on Japan cypress and laied their eggs on it. After fructuous season of cherry, the females were still found to lay eggs on cherry trees. Almost all eggs ovipositing on cherry, mulberry or on plum were parasitized except those early laying on mulberry, while those on Japan cypress did hatch. Most adults emerging in late summer entered hibernation in late fall and their hibernating sites were found in the forest floor of Japan cedar. The oviposition and activity of the newly emerging adults decreased when they were reared under a short-day photoperiod.

8R-2,6 MIGRATION AND SEASONAL TREND OF *PLAUTIA STALI* SCOTT (HETEROPTERA: PENTATOMIDAE) AMONG ITS FEEDING PLANTS.

Moriya, S. and Shiga, M. (Fruit Tree Research Station, Tsukuba, Ibaraki, 305 Japan)

Plautia stali is known as one of the most serious pests of tree fruits in Japan. Since it is multivoltine and usually lives outside of orchards, its control is very difficult and the ecology of this bug remains largely unknown. We devised a new marking method both stable and causing minimum damage to the bug (Moriya and Shiga, 1980). The results of field investigations showed that after the completion of overwintering, adult males selected Japanese cedar, Japanese cypress, paulownia, cherry tree, and mulberry, while females tended to aggregate on mulberries. Presence of fruits on those plants seemed to have a great influence upon the distribution and fluctuations in the number of *P. stali*.

8R-2,7 BIONOMICS OF TUFTED APPLE BUDMOTH IN NORTH CAROLINA APPLE ORCHARDS.

Rock, G. C. and Shaffer, P. (Dept. Ent. N.C. State Univ., Raleigh, N.C. 27650 USA)

Male seasonal flight activity of the tufted apple budmoth, *Platynota idaeusalis* (Walker) (Lepidoptera: Tortricidae) was determined over a four year period using pheromone traps in 47 commercial apple orchards in North Carolina. Two distinct moth-catch peaks were found, the first occurring in mid-April and the second in mid-July to mid-August. The relationship between the occurrence of peak flight periods and environmental temparature will be discussed. Larvae were reared at various combinations of temperature (60, 70, and 80°F) and photoperiod (10, 11, 12, and 16/day) to determine how these factors interact in the induction and duration of larval diapause. At 70°F, under long photoperiod larval development was completed in about 35 days, while under short photoperiod the larval stages were lengthened and additional larval instars were passed through without growth. Under short photoperiod the majority of larvae had not pupated within 125 days, indicating larval diapause.

8R-2,8 ON THE POPULATION FLUCTUATIONS OF THE PEAR LEAF MINER, *BUCCULATRIX PYRIVORELLA* KUROKO.

Fujiie, A. (Chiba Agric. Exp. Stn., Chiba, 280-02 Japan)

Life table studies of the pear leaf miner which is a major pest of Japanese pear were carried out in order to investigate the mechanism of population fluctuation. The survivorship curves in the 2nd and 3rd generations which resembled Deevey's ''Type I'' were similar to Deevey's ''Type II'' in the 1st generation in the commercial orchards where insecticidal sprays were frequently applied. The survivorship curves at the egg and larval stages of overwintered 4th generation were similar to those of the 2nd and 3rd generations, but the pupal mortality was higher in the overwintered generation than in the 2nd and 3rd generations. The larval mortality was mainly due to the insecticides sprayed. The quantity of insecticides deposited on pear leaves tended to decrease with the advance of season. The high mortality of overwintered pupae was mostly caused by predation of birds. Change in fecundity tended to increase from the overwintered generation to the 3rd generation. The population fluctuations from generation to generation seemed to be influenced by the changes in fecundity of each generation and in the efficacy of insecticides.

8R-3,9 THE ORIENTAL FRUIT-FLY, *DACUS DORSALIS* HENDEL, A MAJOR PEST OF MALAYSIAN FRUITS.

IBRAHIM, A.G. (Dept. Plant Protection, Agricultural University, Serdang, Selangor,
Malaysia)

The oriental fruit-fly, *Dacus dorsalis* is prevalent in fruit growing areas throughout the country. It is a serious pest of fleshy fruits such as Carambola (*Averrhoa carambola*), Papaya (*Carica papaya*), guava (*Psidium guava*) etc. Monitoring of adult populations using methyl-eugenol showed the continuous presence of the pests in the orchards. The fly population is positively correlated ($r = 0.56$) with rainfall. Laboratory studies of host preference of selected tropical fruits showed that Papaya > Carambola > Banana > Mango > citrus > pineapple. The possibility of using integrated control of the pests are also discussed.

8R-3,10 PRESENT STATUS OF MASS REARING THE OLIVE FRUIT FLY, *DACUS OLEAE.*

Tsitsipis, J. ("Demokritos" N.R.C., Aghia Paraskevi Attikis, Greece)

The existence of an efficient mass rearing system for the olive fruit fly, *Dacus oleae* (Gmelin), is indispensable for the implementation of the sterile insect technique method. Presently, the insect is reared in moderately large numbers at a production cost, including labor and materials, of $ 0.60/1000 pupae. Despite of a twentythreefold cost reduction over the last few years, further improvements are needed for efficient large number production. Preliminary results showed that contributions toward this goal are: a) Increase of adult density in the cages by double, b) an improved adult diet (30g yeast hydrolyzate, 80g sucrose, 6.6 spray-egg yolk), c) use of a large tray for larval rearing (1400g diet) that was found to be equally efficient with a previous one (230g diet). Still, there appeared occasionally serious problems of microbial contamination of the diet in the large trays, that need further investigation.

8R-3,11 DISPERSAL ACTIVITY OF MALE MELON FLIES.

Hamada, R. (Okinawa Br., Tro. Agr. Res. Cen., Okinawa, 907-01 Japan)

The dispersal activity of melon flies (*Dacus cucurbitae*) was studied in Ishigaki Island, Okinawa, Japan. Lure traps with no insecticide were used to assure the release of captured native flies. The results obtained are discussed in relation to density estimation method, etc.

8R-4,12 STERILIZATION OF THE MELON FLY, *DACUS CUCURBITAE* COQUILLETT, WITH GAMMA RADIATION: EFFECT OF DOSE RATE ON STERILITY AND MATING COMPETITIVENESS OF IRRADIATED MALES.

Teruya, T. (Okinawa Pref. Agric. Exp. Stn., Sakiyama-cho, Naha, 903 Japan)

To assess whether sterility and mating competitiveness of irradiated male melon fly are affected by dose rate, 3 different dose rates (1.1, 9.6 and 87.0 kR/h) were used to deliver dose of 12 kR. Pupae were irradiated 2 days before adult emergence. At these 3 different dose rates a dose of 12 kR caused same effect, almost complete sterility in males. Mating competitiveness of irradiated males against unirradiated males was evaluated by the method of direct counting of flies *in copula* (Teruya and Zukeyama, 1979). At dose rates of 9.6 and 87.0 kR/h there was no reduction of mating competitiveness, but at a rate of 1.1 kR/h there was some reduction.

8R-4,13 COMPARISON OF MATING TRAITES BETWEEN THE WILD AND MASS-REARED MELON FLIES, DACUS CUCURBITAE.

Nakamori, H. and H. Soemori (Yaeyama Branch, Okinawa Pref. Agric. Exp. Stn., Hirae, Ishigaki, 907-01 Japan)

For monitoring the quality of mass-reared melon fly, the difference of mating traites between the wild and mass-reared flies was tested.
1) Sexual maturation was compared between the wild and mass-reared flies. The pre-mating period was shorter and the proportion of mated flies was higher in the mass-reared flies than that in the wild ones.
2) The mating competitivenes of the mass-reared male flies against the wild ones tested with 3 different size cages.
The mating competitiveness of the mass-reared flies surpassed that of the wild ones in smaller two cages. In the largest cage, however, the mating competitiveness of the mass-reared flies was nearly same as that of the wild ones.
These mating traites of the mass-reared flies were seemed to be a consequence of some selection in the course of continued mass-rearing.

8R-4,14 OVIPOSITION OF MELON FLY, DACUS CUCURBITAE, IN RELATION TO PHOTOPERIOD, TEMPERATURE AND FOOD.

Kawai, A. (Ent.Lab., Kurume Branch, Veg.& Ornam. Crops Res. Stn., Kurume, 830 Japan)

In the temperate zone, melon flies that have emerged in autumn lay a few eggs even in winter but flies that emerge in winter do not lay. The effect of temperature, photoperiod and food on the oviposition of melon flies are studied. When adult food is not suitable, flies that rear in 10L14D at 20 C do not lay but flies that rear 14L10D at 20 C, 10L14D at 25 C or 14L10D at 25 C lay a few eggs. Pupal stage is highly sensitive to photoperiod. The ovaries of flies do not grow in 10L14D at 20 C. When adult food is suitable, photoperiod (10L14D or 14L10D) and temperature (20 C or 25 C) do not affect the oviposition of melon flies. Excessively short daylength (6L18D) deters the ovarian development. Since adult food condition is not suitable in the field in winter, short daylength and low temperature control the oviposition of melon flies

8R-5,15 RESISTANCE TO POTATO TUBER MOTH (PHTHORIMAEA OPERCULELLA (ZELLER).

Raman, K.V. and Palacios, M. (International Potato Center, Apartado 5969, Lima, Peru)

A simple rapid screening method is described to identify potato clones resistant to potato tuber moth, *Phthorimaea operculella*. A total of 2,000 clones from various sources were tested. Several had reduced injury. Of the 770 clones screened from the world potato germplasm maintained at the International Potato Center, 24 clones were selected for further resistance trials. Three clones resistant to the root-knot nematode (*Meloidogyne incognita* complex) were resistant with high levels of antibiosis to the potato tuber moth. Oviposition tests indicated significant egg laying differences in clones selected for resistance to the larvae. In field studies tuber depth was significantly correlated with tuber damage (r = -0.5197).

8R-5,16 IDENTIFICATION OF SOURCES OF RESISTANCE TO SWEET POTATO WEEVIL.

Talekar, N.S. (Asian Vegetable Research and Development Center (AVRDC), P.O. Box 42, Shanhua, Tainan, Taiwan 741, China)

Sweet potato weevil (*Cylas formicarius*) is a serious pest of sweet potato both in the field and in storage in tropical to subtropical Southeast Asia and elsewhere. At the Asian Vegetable Research and Development Center in Taiwan, over five years ago, we launched a large scale varietal screening program to identify sources of resistance to this pest in the field. The screening is done at two locations in Taiwan. We plant the germplasm between heavily infested source rows of a susceptible sweet potato variety maintained in a nursery over several seasons to minimize escapes. We harvest the roots and cut them into 2.5mm thin slices and count the number of insects (grubs+pupae+adults) per unit weight as well as weigh the damaged root slices. The resistance rating is based on the statistical mean and standard deviation of the insect number and % root damage as well as a combination of both. Considerable differences in resistance rating is observed from season to season and location to location. We have screened over 300 sweet potato accessions, many of them several times, to make sure that the resistance reaction is consistent. Only two accessions, I-123 and I-152, have shown a consistant moderate resistance to this insect during at least 6 seasons. We are using them as parent materials for breeding the resistance into a agronomically desirable varieties.

8R-5,17 EVALUATION OF RICE, *ORYZA SATIVA* (L.), GERMPLASM FOR RESISTANCE TO THE RICE WATER WEEVIL, *LISSORHOPTRUS ORYZOPHILUS* KUSCHEL.

Smith, C.M., Robinson J.F., and Trahan G.B. (Dept. Ent., La. St. Uni. Baton Rouge, La. 70803, and USDA/SEA/AR Rice Exp. Sta., Crowley, La. 70526 USA).

To date, comparatively little information exists regarding plant resistance in rice, *Oryza sativa* (L.) to the rice water weevil, *Lissorphoptorus oryzophilus* Kuschel. For this reason, a large scale rice germplasm evaluation program was initiated in 1979 at the Louisiana State University Rice Experiment Station in Crowley, LA. Since then over 2,400 rice varieties and breeding lines have been evaluated for resistance to adult and larval *L. oryzophilus* feeding damage in randomized field plots and laboratory studies. Larval population estimates were obtained from 9.2 cm diam soil-root core samples washed with high-pressure water hoses, and adult feeding damage was visually estimated on a rating scale of 1-5 where: 1= no feeding; and 5= numerous feeding scars over the entire leaf surface.

Adult leaf feeding ratings were moderate to high on the majority of all lines, however some genotypes had low adult leaf feeding damage and low larval populations. Among all genotypes evaluated, less than 1% consistently sustained larval populations of $\leq$ 10 larvae/soil-root core. Among 12 parent lines of currently cultivated U. S. rice varieties, none exhibited any strong degree of resistance to either adult or larval feeding damage. No correlations existed between varietal maturity and insect damage.

8R-5,18 HOST RESISTANCE-BREAKING BIOTYPES OF THE BROWN PLANTHOPPER

Sogawa, K. (Trop. Agr. Res. Center, Ibaraki, 300-21 Japan)

It has been recognized that the brown planthopper, *Nilaparvata lugens*, exists as a complex of populations, which are commonly referred to as "*biotypes*", with different ability to defeat genetic resistance of rice, *Oryza sativa*. Investigations were carried out on the biology and genetics of the three biotypes (biotypes 1, 2 and 3), which are being maintained as populations on susceptible *TN 1*, as well as resistant *Mudgo* and *ASD 7* varieties, respectively, in the greenhouse at IRRI.

There were no biotype specific morphological or biochemical characteristics that would be useful as genetic markers for identification of biotypes. However, biotypes were found to differ significantly in their host preference and feeding responses as well as nymphal development and fecundity on the resistant varieties. Particularly, differential feeding responses of biotypes to resistant varieties seemed to be a crucial factor responsible for their different performance on those resistant varieties. Also difference in the reproductive potential among biotypes could account for the reason why biotype 2 prevailed more readily than biotype 3 in the field.

Breeding experiments indicated that physiological traits characteristic of biotypes 2 and 3 were generally inherited in a recessive or intermediate way when these were hybridized with biotype 1, and no definite segregation was recognized in the F_2 and backcrossed progenies. From these findings it seems more reasonable to assume that physiological traits of biotypes 2 and 3 associated with host resistance-breaking ability are controlled by polygenic or quantitative inheritance. It is also considered that these biotypes develop by accumulation and recombination of various effective minor genes under the selection pressure in the form of wide range cultivation of particular resistant varieties.

8R-5,19 SCREENING OF WOUND-EMITTED LEAF VOLATILES IN WILD TOMATO SPECIES - A KEY TO CHEMICAL CHARACTERS OF PLANT PEST RESISTANCE?

Andersson, B.A., Lundgren, L., Norelius, G., and Stenhagen, G. (Dept.Biochem.Ecol., Göteborg Univ., 431 33 Mölndal Sweden)

Seedlings of Lycopersicon cheesmanii, L. cheesmanii v. minor, L. chilense, L. hirsutum, L. hirsutum f. glabratum, L. pauriflorum, L. chmieleneshii, L. peruvianum, L. peruvianum v. humifusum, L. pimpinellifolium, and Solanum pennellii have been investigated. Fresh leaves were wounded in a standardized way with a specially designed tothed roller. Wound-emitted chemicals were adsorbed on a porous polymer (Tenax). The desorbed samples were condensed in a cold trap and injected on the column of a capillary gas chromatograph adapted to give reproducible retention time values. The different tomato species gave characteristic chromatograms superimposing the intraindividual and the intraspecific variation of leaf volatiles. In total 59 components were listed in the different tomato species (background peaks and peaks $<0.1\%$ excluded). Rather few and more volatile components are emitted by L. peruvianum (16 components), and L. pimpinellifolium (18 components). L. hirsutum, known to be highly resistant against insects and other pests, were qualitatively and quantitatively outstanding with 49 listed components. Still more components were obtained from this species when the trichome contents were isolated and concentrated. A number of these tomato leaf components have been identified with capillary GC/MS. We need biochemical methods of selection to be able to collect and to use germ plasm collections to broaden the genetic base of crop plants especially concerning chemical characters of pest resistance. It is suggested that screening of wound-emitted leaf chemicals will prove to be such a method.

8R-6,20 SEASONAL OCCURRENCE OF SUGARCANE LEAF-HOPPERS AND PLANT-HOPPERS IN PERAK, MALAYSIA.

Lim, G. T. and Pan, Y. C. (Ent.Dept., Sugarcane Exp. Station, Gula Perak Berhad, Pantai Remis, Dindings, Perak, Malaysia.

A survey of seasonal occurrence of sugarcane leaf-hoppers and plant-hoppers was made in Perak, Malaysia during 1974 to 1975.

The species of delphacids : Tropidocephala sp. T. signata Dist, Eoeuroysa flavocapitata Muir, Perkinsiella saccharicida Kirk, Nilaparvata lugens (Stal), Cemus sp. and Sogatella sp. and the cicadellids : Yamatotettix flavovittatus Mats. and Kolla sp. were recorded as the most abundant pest species occurring in that area. Their seasonal distribution and the periods of peak activity were observed. The relationship between the rainfall, temperature and the peak of activity of these pests is discussed.

8R-6,21 ASSESSMENT OF THE LOSSES OF LOWLAND RICE, SOYBEAN, AND MAIZE YIELDS CAUSED BY RATS AND INSECT PESTS AT FOUR LOCATIONS IN IRRIGATED AREAS IN JAVA, INDONESIA.

Mochida, O. (IRRI-CRIA), & Tatang, S. (CRIA, Sukamandi, Kab. Subang, West Java, Indonesia)

The yields in intensively controlled plots with insecticides were compared with those in untreated plots from the wet season 1974/75 to the wet season 1978/79. At Sukamandi (W. Java), rice yield losses in the wet season, dry season, & annual (wet + dry season) crops were 12, 47, & 28% due to rats; 43, 17, & 31% due to insects in Pelita I-1, a high-yielding cultivar, susceptible to the brown planthopper (Nilaparvata lugens). Soybean losses were 38, 38, & 38% due to insects, whereas maize losses were 20, 28, & 23% due to insects, respectively. At 3 locations (W., C., & E. Java), rice yield losses were 25-80, 36-54, & 29-61% in Pelita I-1; 11-53, 19-49, & 15-51% in IR26, 28, 30, & 34 (resistant with BPH 1 gene to the BPH); 16-58, 11-30, & 17-45% due to insects in IR32 (resistant with bph 2), respectively. Those were 0-4, 0-14, & 0-6% due to rats, irrespective of cultivars, respectively. These indicate the possibility of raising the present annual rice yield theoretically upto 1.0-1.7 times by improving rat control; 1.5-1.7 times in Pelita, 1.3-1.7 times in cultivars with BPH 1, 1.2-1.8 times in IR32 by improving insect pest management. Soybean & maize yields may increase upto 1.6 & 1.3 times, respectively, by improving insect pest management.

8R-6,22 THE GIANT MOTH BORER CASTNIA LICUS DRURY, 1770 (LEPIDOPTERA: CASTNIIDAE) IN BRAZIL.

Mendonça, A.F. (Seção Ent., Cx. Postal 162, Maceió, Al, Brazil)

The giant moth borer Castnia licus Drury, 1770 (Lepidoptera: Castniidae) has been considered one of the most important pests in the sugar cane areas of North and Northeast Brazil, mostly in the States of Alagoas, Pernambuco, Paraiba and Rio Grande do Norte. In some of the sugar cane areas (where the occurence of the pest is very high) was observed a damage up to 70%, in plant and ratoon canes. In general, the damage due to this pest can cause a sugar loss of about 5% - year. A female is capable of laying down 50 to 80 eggs, generally 3 to 5 per cane stool. The larva open a tunnel within the cane stalk causing an internal damage in the first basal internodes, after that takes place the pupa stage. C. licus complete its biological life cycle in nearly 177 days, with the following stages: a) 10 days, incubation stage; b) 110 days, larval stage; c) 45 days, pupa stage and b) 12 days, the adult stage. Generally, this pest's life cycle occurs twice a year. Diferent methods of control were already studied. Manual and mechanical control methods showed to be more efficient.

8R-6,23 INSECT AND MITE PESTS OF CULTIVATED MUSHROOMS-AN OVERVIEW OF THE ARTHROPOD PEST PROBLEMS OF THE EASTERN HEMISPERE.

Tsai, Y.P. (Kwanshi Citrus Exp. Stn., Taiwan, 306 ROC)

The pests of mushroom include cecid flies, phorid flies, sciarid flies, springtails and mites. Cecids reproduce rapidly by paedogenesis under favorable conditions, are the commonest pest. Cecid damage in the mushroom industry greatly affects the quality of the canned product. Development of the mushroom strains unfavorable to the reproduction of cecid larvae, efforts of prevention to the entrance of cecids into mushroom houses, and study on the habits of cecids between non mushroom producing period, must be carried out for reduction of cecid damage. Outside population of phorids, sciarids, springtails and mites, the structure of house, and the management of sweat-out greatly influence the population of those pests in mushroom house. Sanitary measures must be done completely for their control.

8R-7,24 RECENT OCCURRENCE OF THE RICE GALL MIDGE IN THE CENTRAL AND SOUTHERN THAILAND.

Hidaka, T. (TARC, Ibaraki 305 Japan) and Ya-klai, V. (Dept. of Agric., Bangkok 9 Thailand)

The rice gall midge, Orseolia oryzae, has long been one of the most important rice pests in the north and northeast of Thailand, but not in the central and southern rice growing areas. For the first time insect outbreaks were reported to affect the second crop of rice grown in Chachengsao (1978), Nakon Pathom (1979) and Bangkok Provinces in the central plain (1979) with more than 48 % of the tillers being damaged. The insect incidence was also observed to affect the floating rice grown in Nakon Nayok and Ayuthaya Provinces (1978) and rice seedling at Suphanburi Rice Experiment Station (1977). However, the infestation rate was less than 23 %. In 1978, the insect was first recorded in Chumphon and Suratnani Provinces in the southern peninsula with 3 % of the tillers being damaged. The severe outbreak may be due to: 1) the susceptible RD cultivars which are extensively grown and supply ample food, 2)the broadcasting of rice at high density and 3) the irrigation throughout the year which creates a suitable environment for insect reproduction.

8R-7,25 Comparison of biological characteristics of two hymenopterous parasitoids of the rice gall midge, Orseolia oryzae (Wood-Mason) in Thailand. M. Kobayashi and Kadkao, S. (Kyushu Natl. Agric. Exp. Stn. Chikugo, Fukuoka, 833 Japan)

The rice gall midge, Orseolia oryzae is an important rice insect pest in tropical region. In Thailand, two hymenopterous parasitoids, Platygaster oryzae (Cameron) and Platygaster foersteri (Gahan) were annually observed as predominant natural enemies of the pest in the paddy field. Some biological characteristics of both parasitoids such as sex ratios, longevities, reproductive capacities were investigated about the materials collected in the paddy field of Chiang Rai, located in Thailand's northernmost province where natural infestations of the rice gall midge are always observed. Relative reproductive potentials were clarified by releasing them individually into the cages which contained rice plants infested with the host eggs. The characteristics of them were compared as parameters showing degree of r and K strategy gradient. P. oryzae seemed more of a r-strategist than P. foersteri, despite of their systematic close relation.

8R-7,26 DEVELOPMENT OF THE LARVAE OF THE RICE LEAF ROLLER, CNAPHALOCROCIS MEDINALIS (LEPIDOPTERA : PYRALIDAE). Wada, T. and Kobayashi, M. (Kyushu Natl. Agric. Exp. Stn., Chikugo, Fukuoka 833 Japan)

Laboratory experiments showed that the number of instars and the duration of the larvae of the rice leaf roller were influenced by the growing stages of the rice plant. Most of larvae (90-100 %) passed through five instars when reared on rice young leaves, whereas remarkable prolongation of larval development occurred and more than 80 % of larvae reached the sixth-instar stage on rice leaves at the ripening stage. The threshold temperature for larval development was 12.2°C and the thermal constant was 203.7 day-degrees on young leaves. An average duration of the larval stage in each generation in 1978 was obtained from the stage-frequency data in the paddy field. The heat accumulations calculated from the average duration of the larval stage were 210-240 day-degrees for larvae in the generations before mid-August and about 300 day-degrees after late August. This difference might be mainly due to the stage of the food plant.

8R-7,27 EPIDEMIOLOGY OF THE RICE STRIPE VIRUS DISEASE TRANSMITTED BY THE SMALL BROWN PLANTHOPPER (LAODELPHAX STRIATELLUS FALLÉN). Kisimoto,R. (Ent. Lab., Centr. Agri. Exp. Sta.,Konosu,Saitama,Japan 365)

The Rice Stripe Virus Disease (RSV) has a long history of sporadic outbreaks, in relation to changes of agricultural practices in Japan. The recent epidemic was triggered by the introduction of early transplantation of rice plant in mosaic in barley and wheat growing areas. Wheat and barley are the most adequate food plant for the vector before the rice growing season.

Fluctuation of RSV disease occurrence seems to depend on three factors, i.e., density of vector immigrating into paddy field and that of offspring during the susceptible stage of rice plant, percentage of infective insects among the local population concerned, and the susceptibility of the rice plant. Density of vectors was surveyed by various techniques in parallel and percentage of infective insects was traced by the hemagglutination test using antibody-sensitized blood cells. Yearly fluctuation of vector density was rather erratic but that of percentage of infective insects was much less erratic and a sort of damping effect was shown, which render it difficult to eradicate or control RSV below economical injury level.

The percentage of infective insects varies according to three factors, natural decrease due to imperfect transovarial passage of RSV, increase due to acquisitive feeding during rice infesting period, and intermixing populations having different percentage. The percentage of infective insects is an adequate index showing the local epidemic state of RSV, with a consideration of the susceptibility of rice plant due to variety and/or environmental conditions.

Long distance migration of infective insects is also one of the important items in epidemiology of RSV disease.

8R-8,28 SOME FACTORS AFFECTING THE ABUNDANCE OF DAMAGE CAUSED BY THE BROWN PLANTHOPPER IN NORTHERN KYUSHU, JAPAN.

Hirao, J. (Kyushu Nat. Agric. Expt. Stn., Chikugo, Fukuoka, 833 Japan)

The brown planthopper, Nilaparvata lugens Stål (Hemiptera: Delphacidae), is an important insect pest of rice in Asia. The abundance of damage in autumn was closely related to the density of the initial immigrant population during June-July, when several waves of long-distance migrations occur from overseas. During this period immigrant adults preferred the advanced growth stage of rice plants in the early-planted field. When migrations occurred earlier, one more generation grew in late-autumn, causing serious outbreaks of damage. Low temperatures during the young nymphal stage retarded the population growth. The occurrence of hopperburn corresponded to the dates of rice maturity: hopperburn occurred earlier in an early-maturing variety than in a late-maturing variety even if the density of the initial immigrant population was nearly the same.

8R-8,29 A NEW TYPE OF INJURY OF RICE CAUSED BY RICE PLANT WEEVIL (ECHINOCNEMUS SQUAMEUS).

Ôya, S. and Sato, A. (Kyushu Nat. Agric. Expt. Stn., Chikugo, Fukuoka, 833 Japan)

The adult of rice plant weevil has been a rice insect pest, causing damage by boring rice stems in the early season of paddy fields. In recent years, this insect also injures the panicles at the ripening stage and affects the quality of rice grains in Northern Japan. The larva always attaches to the roots with six-paired dorsal hooks on its lateral sides probably to obtain oxygen from the roots. When the soil was drained, the larvae moved from the roots and were assumed to utilize gaseous oxygen in the soil. The matured larvae transferred experimentally to drainage conditions pupated one week after the transfer though they could not pupate at all under flooding conditions. The critical soil condition related to pupation was about 80% water content, which corresponded to pF 0.8. The early drainage accelerated both pupation and adult emergence, and allowed the adults to attack the panicles of rice at the ripening stage. Recently, farmers have drained the irrigation water immediately after the milk-ripe stage of rice plants to use combine-harvesters. Therefore, recent changes in cultivating practices are responsible for the occurrence of this new type of injury.

8R-8,30 COMPARATIVE EVALUATION OF INSECT PEST SEVERITY IN PHILIPPINE RICE AGROECOSYSTEMS.

Litsinger, J.A. (Dept. Ent., IRRI, P.O. Box 933, Manila, Philippines).

Rice culture in the Philippines occurs over a wide array of environments (dryland, rainfed wetland, irrigated wetland), cultural practices (puddled, nonpuddled, direct seeded, transplanted), and cropping patterns (single, double, triple, and continuous cropping) which determine the potential for insect problems. Single crop, dryland rice, having only 4-5 recemonths/year, has the least insect pest problems. Dryland rice has a unique pest and natural enemy complex because the fields are not puddled. The few pest problems that can occur are relatively easy to contain. Single crop, rainfed wetland rice has more serious problems, principally stem borers, whorl maggot, caseworm, leaf folder, and rice bugs, than dryland rice because the number of rice-months ranges from 6-8/year. If these rainfed areas are doublecropped by using early-maturing varieties, the first crop behaves like a dryland crop and is relatively pest free. The second crop has the same degree of pest problems as the single-crop rainfed, wetland rice. In irrigated double- or triple-cropped systems, where a rice crop is grown during the dry season, the number of rice-months/year is extended to 12. These systems share not only the same pest complex as the single-crop, rainfed wetland rice systems but they are also vulnerable to the brown planthopper, hopper vectored virus diseases, and the misuse of insecticide. Continuous cropping, because it creates a stable environment for natural enemies and allows for good rice stubble management, does not pose any greater pest problem than double-cropped irrigated rice.

8R-9,31 FEW RECENT INSECTS INTRODUCTIONS IN FRANCE - ECOLOGICALS AND ECONOMICALS ASPECTS -

d'AGUILAR, J. (I.N.R.A. 78000 VERSAILLES - FRANCE).

Few introductions from America are cited :

Hyphantria cunea Dr. [Lep. *Arctiidae*] has been introduced in Hungary and expanded in central and oriental Europe. In 1977 approximately, this species came near Bordeaux probably from USA following trading exchanges.

Corythucha ciliata Say [Hem.*Tingididae*] lives only on *Platanus*. It appeared in Italy and now is in France.

Liriomyza trifolii Burg. [Dipt. *Agromyzidae*] damages chrysanthemum in America. It has been first imported in Africa (Kenya) where plants are multiplicated, then exported in Europe, especially in Great-Britain and Netherland. In the latter, this fly adapted in greenhouses on chrysanthemum and Gerbera. These plants, introduced in France, are the origine of our infestation.

Ophyra aenescens Wied [Dipt.*Muscidae*] with sarcophagous larvae, has been indicated in Europe, especially in Germany. It justhas been found in France.

8R-10,33 BIOLOGY AND POPULATION ECOLOGY OF *PAUROCEPHALA PSYLLOPTERA* AND ITS PREDATOR, *CHRYSOPA BONINENSIS*.

C.I.T.Shih(Dept. Ent.,National Chung-Hsing Univ., Taichung, Taiwan 400, ROC)

The life histories of the mulberry psyllid, *Paurocephala psylloptera* and its predator, *Chrysopa boninensis*, were studied and their life tables, intrinsic rates of increase, and predation potential of *C. boninensis* were calculated. Completion of a life cycle required an average of 18.9 days for *P. psylloptera* and 38.6 days for *C. boninensis*. The mean generation time was 25.0 days for *P. psylloptera* and 54.2 days for *C. boninensis*. The reproductive rate was 30.4 eggs per female per day for *P. psylloptera* and 12.7 eggs per female per day for *C. boninensis*.

Predation potential for *C. boninensis*, expressed as the number of prey consumed per larva per day, was an average of 5.6, 14.0, and 62.9 prey per day for 1st, 2nd, and 3rd stage larvae, respectively. An average predation potential of *C. boninensis* was 437.8 prey consumed per larva and 32.8 prey consumed per larva per day.

The intrinsic rate of increase was 0.212 female individuals per female per day for *P. psylloptera* and 0.096 female individuals per female per day for *C. boninensis*. The population of *P. psylloptera* multiplied 199 times in a mean generation time of 25.0 days, while that of *C. boninensis* multiplied 181.5 times in a mean generation time of 54.2 days. A field-cage release of both populations of *C. boninensis* and its prey, *P. psylloptera*, was used to evaluate the potential of *C. boninensis* as a biocontrol agent on its prey.

8R-10,34 ARTHROPOD PREDATORS OF THE FLORIDA SOYBEAN FIELD.

Whitcomb, W.H., and J. Stimac (Dept. of Entom. & Nematol., Univ. of Fla., Gainesville, 32611 USA)

We find 1,100 species of predators present in Florida soybean fields. Of these over 250 belong to the Order Hymenoptera and over 250 to the order Araneida of Arachnida. Approximately 60 species of predators attack *Anticarsia gemmatalis*, the major pest of soybeans in Florida. Sources of these 60 predaceous arthropods and factors affecting both their numerical and their functional responses are discussed.

8R-10,35 ANNUAL DEVELOPMENT AND DIAPAUSE OF ATHALIA ROSAE L. /HYM., TENTHRED./ IN HUNGARY.

Sáringer, Gy. /Inst. Plant Prot., Univ. Agric., H-8360 Keszthely, P.O. Box 71, Hungary/

Athalia rosae swarms three times a year in Hungary. The overwintering occurs in the soil, inside a cocoon. The swarming of the overwintered generation begins in the first days of May and lasts about 35 days /until 10 June/. The peak of swarming occurs between 20 and 30 May. This generation lays its eggs on the cultivated mustard /Sinapis alba L./ or on S. arvensis L. The first summer generation begins its swarming at the end of August and the swarming proceeds until the begin of October /Sáringer, 1957 a, b, 1961/. From economic standpoint, the progeny of this generation is the most dangerous, stressed further by the fact that this generation shows the highest individual numbers.

The number of generations per year of Athalia rosae is regulated by the combined effect of photoperiod and temperature. The photophase critical for diapause falls at 18 and 22 °C between 14 and 15 hours /Sáringer, 1964, 1967/.

8R-10,36 SPATIAL PATTERN OF THE DIAMONDBACK MOTH LARVAE ON CAULIFLOWER AND ITS SAMPLING TECHNIQUE.

Chen, C. N. and Su, W. Y. Plant Protection Center (Taiwan), Taichung Hsien, Taiwan 431, R. O. C.

Among five statistical distributions fitted to 1977 and 1978 field data, the negative binomial distribution appears to give an adequate description of the frequency distribution of the Diamondback Moth larvae on cauliflower. The regression equations for the mean crowding - mean ($\overset{*}{m} - m$) relationship were as follow (1) $\overset{*}{X} = 1.29 + 1.23\,\overline{X}$ ($r^2 = 0.9295^{**}$, $n = 14$)(for 3rd plus 4th instar larvae); and (2) $\overset{*}{X} = 1.80 + 1.32\,\overline{X}$ ($r^2 = 0.8810^{**}$, $n = 14$)(for all stages). The required sample size based on counts of larvae on a whole plant at different mean densities will be discussed.

8R-11,37 ECONOMIC THRESHOLD AND INJURY LEVELS OF CEREAL APHIDS FOR BARLEY IN SOUTHWESTERN QUEBEC.

Ba-Angood,S.A.(Department of entomology,Mac. College of McGill Univ. Ste Anne De Bellevue,Quebec H9X 1C0.).

Artificial infestation of cereal aphids in caged plants was made at different stages of barley growth in the field in 1978 and 1979. 40 ,80,160 and 200 aphids/tiller reduced grain yield significantly($P \leq 0.05$) when introduced into caged plants at flowering and milky stages for a duration of 2 weeks. Only the 160 and 200 aphids/tiller- treatments gave significant reduction in yield when introduction was at the mealy ripe stage. 20 aphids/ tiller gave a significant reduction in yield only when they were introduced at the milky ripe stage. Significant reduction in percentage protein was obtained only when 80,160 and 200 aphids/ tillerwere introduced at flowering and milky stages. The economic injury and threshold levels were calculated as 11-18 and 9-16,respectively,depending on rate of increase of aphids,costs of chemical control and the value of the crop in 1978 and 1979.

8R-11,38 THE INFLUENCE OF IMPORTANT CEREAL PESTS ON YIELD1

Wetzel, Th. and Freier, B. (Martin-Luther-Univ.,Dept.Agrochemistry,402 Halle/S., GDR)

By numerous investigations of the influence of wheat bulb fly (Leptohylemyia coarctata Fall.), cereal leaf beetles (Oulema spp.) and English grain aphid (Macrosiphum avenae (Fabr.)) on the winter wheat yield it became possible to lay down obligatory thresholds for carrying-out of the chemical pest control (wheat bulb fly: 60 - 90 eggs/m^2 soil; cereal leaf beetles: 1 - 1,5 eggs and larvae/flag leaf; English grain aphid: 3 - 5 aphids/ear). The present results allow the following general conclusions about the interactions between pest and host plant: 1. The earlier and stronger the pest infestation of the host plants takes place the higher the yield losses might be expected but on the other side the ability of plants for compensation of damages is high too. 2. In the case of slight infestation by the insects the compensation capacity of plants counteracts the reduction of the yield and in the case of strong infestation the factors of the population dynamic like competition, interference and natural enemies limit the damages and prevent total losses.

3. The infestation by several pests at the same time does not result in an intermediate loss. Mainly the loss is an result of the effect of the dominant pest in regard to its number and the duration of the infestation.

8R-11,39 EFFECTS OF MINERAL OIL AND A SYSTEMIC INSECTICIDE ON THE INCIDENCE AND SPREAD OF MAIZE DWARF MOSAIC VIRUS (MDMV) OF SWEET CORN.

Ferro, D.N. and D. MacKenzie (Dept. of Entomology, Univ. of Mass., Amherst, MA 01003).

MDMV is a non-persistant virus of sweet corn vectored by aphids. The four main aphid species trapped in the experimental area in Massachusetts, USA, were: corn leaf aphid, Rhopalosiphum maidis (Fitch); English grain aphid, Macrosiphum avenae (F.); green peach aphid, Myzus persicae (Sulzer) and potato aphid, Macrosiphum euphorbiae (Thomas). One percent of the plants were inoculated with MDMV strain-B at the four leaf stage. The treatments were: 1) aphicide at planting (aldicarb), 2) aphicide at planting and mineral oil, 3) mineral oil, and 4) untreated control. The aldicarb and mineral oil plots had the lowest apterous aphid counts throughout the season, while the mineral oil alone had the highest counts. The treatments receiving mineral oil had the lowest incidence of MDMV (ca. 15%), followed by the control (ca. 22%) and the highest incidence was in the aldicarb plots (ca. 30%). The spread of MDMV from the sites of inoculation was greatest in the aldicarb plots.

8R-12,40 INSECTICIDE MANAGEMENT FOR CONTROLLING THE TROPICAL CORNBORER, OSTRINIA FURNACALIS GUENEE' IN THAILAND.

Meksongsee, B., and Kongkanjana, A. (Div. of Ent. and Zoo., Dept. of Agric. Bangkok, Thailand)

Investigation was done on the control of the tropical cornborer, Ostrinia furnacalis Guenee' on field corn as well as on sweet corn with insecticides. Emphasis was made on the minimum use of the chemicals in order to avoid destruction of parasites of the borer and pollution of the environment. Where the early infestation was light, usually only the ears were sprayed during the ear-forming stage with 0.05% endring or 0.2% EPN. Two applications were sufficient to give good protection. The first application was made when the plants were tasselling, followed by a second tratment a week later. Where the borer was abundant, 1/2 gram of carbofuran granules 3 G was applied into the whorls of one-month old plants, then repeated after 15 days. Alternatively, endrin or EPN was sprayed as two applications at 10 days interval at whorl stage, followed by another two sprays with one week interval at tasselling stage.

8R-12,41 Insects affecting asparagus and their control.

Yung-tung Ou. (DU PONT FAR EAST INC, TAIWAN.)

Prodenia litura Fab; *Melanotus tamsuyensis* Bates, are the most destructive to the spear and storage root of asparagus. Available control measures include poison bait, treatments with chemical granules, and also flooding.

8R-12,42 INSECTICIDAL RESISTANCE IN TURFGRASS-INFESTING SCARABAEIDAE AND PERFORMANCE OF NEWER ORGANOPHOSPHATE INSECTICIDES.

Tashiro, H. (Dept. Ent. New York State Agr. Exp. Sta.,Geneva,New York14456)

The European chafer and the Japanese beetle whose larvae are the two most serious insect pests of turfgrass culture in northeastern U.S. developed resistance to all the chlorinated cyclodiene insecticides during the past 10 years. Sufficient residues are still present after 1 to 3 decades to provide protection against turfgrass damage where susceptible strains are still present but these areas are gradually disappearing. Poor performance of currently registered materials, namely, chlorpyrifos, diazinon, and trichlorfon are creating speculations that organophosphate resistant strains are developing. There is still no experimental evidence to substantiate such developments but such an occurrence is highly probable. Laboratory and field experiments with isofenphos, Amaze^R, a new organophosphate insecticide indicate that this is the most promising new material for scarabaeid larval control due to its relatively long residual activity and its stability against rapid hydrolysis under alkaline conditions. In all tests over the last two years, April applications at the rate of 2.24 kg/hectare, considered to eventually become the 1X rate, had sufficient residue to provide equally as good or better larval reductions during the last summer than during the spring. Second year residues of the 1X rate appear to have dissipated sufficiently to give only limited larval reductions in most cases and create no serious environmental concerns.

8R-13,43 INSECTICIDE AND ACARICIDE TESTS - AN INTERNATIONAL PUBLICATION ON PESTICIDE SCREENING.

Sorensen, K. A. (Dept. Ent., N. C. State Univ., Raleigh, NC 27650 USA)

Insecticide and Acaricide Tests is an annual publication on pesticide screening for entomologists in the United States and other countries. This Entomological Society of America publication, now in its sixth year, continues to serve the vital need for the annual dissemination of data and progress on candidate pesticides in man's environment and on his crops and animals. Specific objectives include: a suitable publication for assembling information on the performance of materials for insect and mite control, the rapid dissemination of such information and to improve insecticide and acaricide testing and reporting. The format is forthright, concise and parallels *Fungicide and Nematicide Tests*, a sister publication of the American Phytopathological Society. Guidelines in preparing reports and in ordering are contained in each volume of *Insecticide and Acaricide Tests*. Three copies of the complete report should be mailed to the editor before November 30. *Insecticide and Acaricide Tests* is available in May each year.

8R-13,44 EVALUATION OF SYNTHETIC PYRETHROIDS AND *BACILLUS THURINGIENSIS* TO CONTROL VEGETABLE INSECT PESTS IN BRAZIL. Barbosa, S. and França, F.H. (UEPAE-BSB/EMBRAPA C.P. 1316 Brasília-DF-BRAZIL).

The diamondback moth (*Plutella xylostella* L.), the melonworm (*Diaphania hyalinata* L.) and the pickleworm (*D. nitidalis* (Stoll) are among the most important insect pests of vegetables in Brazil. *P. xylostella* is the key pest in most of the Brazilian cole crop production areas with suspected resistance to most organophosphate and carbamate insecticides. Both *Diaphania* species are getting harder to control with traditional insecticides and the fast rate of development of the cucurbit fruits limits the choice to short term residual insecticides. Several experiments were carried out in Brasilia, at the EMBRAPA'S Truck Crop Experiment Station, during 1979, to evaluate the performance of three different pyrethroids and *B.thuringiensis*, when compared to traditional sprayings, to control *P. xylostella* on cabbage and the *Diaphania* complex on cucumber and on zucchini squash.. Decamethrin, permethrin and fenvarelate gave outstanding control of the three mentioned species with seven-day interval applications. Decamethrin and fenvarelate were very efficient at small dosages as 5g a.i./ha while permethrin gave the same results at 50g a.i./ha. *B. thuringiensis* at the rate of 500g/ha of Thuricide provided oustanding control of *P. xylostella* larvae and fair control of the *Diaphania* larvae.

8R-13,45 RESEARCH ON THE USE OF SYNTHETIC PYRETROIDS FOR ORCHARD PEST CONTROL IN POLAND.
Suski Z.W., Niemczyk, E., Koślińska, M., Nowakowski, Z. /Res. Inst. Pomol. Floricult. 96-100 Skierniewice, Poland/

A number of compounds including: permethrine, decametrine, cypermethrine and fenvalerate were investigated for three to five years in field experiments. Their effectiveness was evaluated in controling important pests, such as: codling moth, Laspeyresia pomonella L., winter moth, Operophthera brumata L., black current twig borrer, Synanthedon tipuliformis Cl., leaf miners /Lithocolletis sp. and Scitella sp./, leaf rollers /Tortricidae/ etc. using both, standard and ULV spraying techniques. Influences of certain pyretroids on beneficial arthropods are reported on the bases of laboratory trials. Advantages and disadventages of their use in commercial orchards are discussed.

8P,1 MASS REARING OF THE ORIENTAL FRUIT FLIES IN TAIWAN. Chiu, H.T. (Taiwan Prov. Ping-Tung Inst. Agr. Taiwan, 900 ROC)

In Taiwan, based on rearing facilities, we can currently produce 25 million pupae per week. In the rearing room, adult flies provide with sucrose and protein mixtures. Ten days after emergence, eggs were collected twice per week, and were seeding into the larval media. Matured larvae pop into sawdust and pupate. Currently, we get 55-60 per cent of pupal recovery from eggs. Pupae were sieved from sawdust and kept temperature at 27. or 20°C to adjust the appropriate pupal period. Under this rearing methods, the estimation of the rearing material cost is ca. US$ 20.48 per million pupae.

8P,2

CONTROL THRESHOLDS FOR MAJOR CATERPILLARS ATTACKING CAULIFLOWER IN TAIWAN. Chen, C. N. and Su, W. Y. Plant Protection Center (Taiwan), Taichung Hsien, Taiwan 431, R. O. C.

The control thresholds for both *Plutella xylostella* (L.) and *Pieris rapae crucivora* Boisduval on cauliflower were determined through the following approaches. (1) An artificial defoliation and a preliminary control strategy study were conducted during 1976 winter crop. (2) Consequently, tentative control thresholds for the Diamondback moth (DBM) were tested in the field during 1977 winter crop by applying Dipel® plus Pirimicarb®. Field surveillance was made at 5 to 7-day interval and population changes of DBM were recorded. From cost/benefit analysis, we concluded that 10 DBM larvae/10 plants before heading was the most appropriate threshold. (3) Finally, by employing DBM-equivalent Units the tentative control thresholds for both pest species were evaluated again during 1978 winter crop. We concluded that 10 DBM units/10 plants before heading and 100 units thereafter were the most profitable control thresholds for both pests, provided that the sprout or head was not attacked. Accordingly, only 4 applications were needed to maintain pest numbers below that level, in comparison to conventional 9 times. The benefit was about US$ 6 return per $ 1 input.

8P,3

ASSAM THRIPS OR CHILLI THRIPS (*SCIRTOTHRIPS DORSALIS* HOOD) AS THE CAUSE OF SCARRED FRUIT OF SATSUMA ORANGE (*CITRUS UNSHIU* MARCOV.). Matsunaga, Y. and Nishino, M. (Shizuoka Pref. Citrus Exp. Stn., Shimizu, 424 Japan)

The result obtained from epidemiological survey for occurrence distribution of scarred fruit of satsuma orange (*Citrus unshiu* Marcov.) showed that the area of its occurrence was obviously coincide with the area cultivated tea plant. As *Sci. dorsalis* is one of the most popular injurious insect on tea plant, this species was expected to be the cause of scarring.

In 1968 nymphs and adults were found on young fruit and its population was closely related with the degree of injured fruit. The relation between its infestation and scarring was also confirmed by the improvement of artificial inoculation technique and microscopic investigation.

The most of adult population in orange field depend upon the continuous immigration from tea orchard and other host plant, the control measures, therefore, must have long residual effect. Maneb, mancozeb and acephate are recommended to protect the fruit from scarring.

8P,4

THE SPECIES STRUCTURE OF HETEROPTERA OF NIGERIAN COCOA FARMS. Nwana, E. Ifediorамma (Department of Agricultural Biology, University of Ibadan, Ibadan, Nigeria)

The Heteroptera fauna of a 5.1 ha farm of mature Amelonado cocoa at Agodi, 8 km south-east of the University of Ibadan, Ibadan, was sampled for 27 months (November 1971 to February 1974) by four methods; suction trap, sweep net, sticky traps and direct counts. Altogether, 8005 specimens comprising 128 species in 20 families of Heteroptera were collected. All the specimens have been determined to the family and sub-family levels. However, while the generic status of 89.9 percent have been determined, only 51.7 percent have been fully identified to the species. This situation places considerable emphasis on the urgent need for increased taxonomic studies on the Heteroptera, and indeed all insects inhabiting cocoa farms in order to be able to describe and fully understand the ecology of these cocoa farms.

The species structure of the Heteroptera at Agodi was adequately described by the log. series thus suggesting some similarity between the Heteroptera fauna of Nigerian cocoa farms and those of the natural ecosystems of the tropical rainforests.

Six other farms in south-western Nigeria and one farm in south-eastern Nigeria were sampled in 1973. When the indices of diversity in the Heteroptera fauna of these farms were calculated, there were considerable overlaps in the 95 percent fiducial limits of the different indices of diversity indicating that the species structures of the Heteroptera of Nigerian cocoa farms are essentially similar.

8P,5

MEDITERRANEAN FRUIT FLY PROGRAM IN MEXICO

Patton, P. Guillermo Perez Valenzuela 127 Mexico, 21 D.F.

A large scale program has been established in Mexico for the prevention, control and erradication of the Mediterranean fruit fly, invading the country from the south.

Activities include, a trapping network, fruit monitoring, large scale spraying of bait sprays, and a laboratory that produces--500 million sterile flies per week.

8P,6

The oriental fruit moth Grapholitha molesta Busck in the USSR,

107139 Moscow Orlikov pereulok 1/11; State quarantine inspection, Ministry of Agriculture of the USSR;

Lebedev V.A.

The oriental fruit moth was detected for the first timi in the USSR in 1964 in the region of Krasnodar and then distributed to Transcaucasus, the south of Ukraine and Moldavia. The study of the biology demonstrated that the pest had 3 - 5 generations in the year. In some regions of the USSR the level of damage of peaches, pears and quinces 100%. The late varieties of peaches and pears are the most damages. For focus''detection and for control of the pest synthetic sex pheromones are used. To prevent the spreading of the oriental fruit moth the fruits are fumigated with the mixture of metyl bromide and CO_2. In the nurseries all planting material is fumigated with metyl bromide before shipping for consumers. The system of quarantine mesures used at present allows to withstand further spreading of the oriental fruit moth on the territory of the Soviet Union.

8P,7

STRATEGY FOR MUNG BEAN AND COWPEA INSECT CONTROL IN ASIA.

Litsinger, J.A. (Dept. Ent., IRRI, P.O. Box 933, Manila, Philippines).

Insects and insect-vectored virus diseases are the major limiting factors in mung bean Vigna radiata and cowpea V. unguiculata production in Asia. Chemical control forms the main insect control tactic for postflowering pests such as pod borers and seed bugs. If these grain legumes are sown into standing rice stubble (>10 cm), as is common in Asia, beanfly Ophiomyia phaseoli, Thrips palmi, leafhopper Amrasca biguttula, and Aphis craccivora populations are suppressed for 2-3 weeks. Rice straw mulch controls the above preflowering pests with the exception of the beanfly. These cultural control practices may reduce the chemical requirement which normally consists of 3-5 applications per crop. Host plant resistance and biological control tactics have not been developed for these crops in Asia and need more attention from research. Granular systemic insecticides applied in seed furrows are costly but effective against preflowering insects in dryland environments but nor on previously puddled fields. Water for sprayers is a problem particularly in the drylands. Seed tratment and the controlled droplet insecticide applicator can overcome problems of water and cost. Timing of insecticides is crucial both for good control and reducing cost.

8P,8

REPORT ON THE USE OF PHEROMONE-BAITED TRAPS FOR THE CONTROL OF THE EGYPTIAN COTTON LEAFWORM AND THE PINK BOLLWORM BY MASS TRAPPING ON COTTON IN EGYPT.

Hosny,M.M., El-Saadany, G.B., Iss-hak,R.R. (Ain Shams University, Cairo), El-Naggar,S. (Cairo University, Cairo), Nasr,E.A., Mouawad,G.I. (Ministry of Agriculture, Cairo) and Critchley,B.R., Topper,C., Campion,D.G. (Centre for Overseas Pest Research, London).

This report will concentrate on results obtained from field trials carried out in a semi-isolated area in the Fayyoum Province of Egypt during the period Feb. - July 1980 to reduce and maintain populations of two of the most important pests of cotton, SPODOPTERA LITTORALIS (Boisd.) and PECTINOPHORA GOSSYPIELLA (Saund.), to below their economic threshold levels. This work is a collaborative effort in which the institutions, underlined above, are involved.

8P,9

The Role of Mineral Fertilizers in Regulation the Numbers and Harmfulness of Plant-Eating Insects in Cereal Agrocenosis.

Samersov V.F. 223011. Minsk p/o Priluki. The Byelorussian Scientific Research Institute for Plant Protection, USSR.

The role of mineral fertilizers on the numbers dynamics and harmfulness of different groups of insects is shown. It is stated, that the 8 years annual application of mineral fertilizers decreased the numbers of soil larvae Elateridae. On the contrary, what concerns frit flies, their harmfulness is decreased under the influence of high dosages of mineral fertilizers in the result of plant development acceleration and other factors. The elevated balanced dosages of mineral fertilizers, especially nitrogen, lead to the acceleration of the insect development and the increase of fecundity (aphis, thrips). It is very important to concider all these factors while working out the tactics of numbers and harmfulness management.

8P,10

STRATEGY FOR CORN AND SORGHUM INSECT CONTROL IN SOUTHEAST ASIA.

Litsinger, J.A. (Dept. Ent., IRRI, P.O. Box 933, Manila, Philippines)

In Southeast Asia, corn and sorghum are attacked in the seedling stage by the highly seasonal seedling maggot or shoot flies (Atherigona spp.). Crops planted during peak periods of infestation can be cheaply and safely protected with bendiocarb seed tratment. Ants, which reduce plant stands in dryland culture, can be readily controlled with a low cost insecticide or kerosene seed treatment. However ants are not a problem to corn or scrghum in wetland puddled rice environments. Heliothis armigera is the most serious postvegetative pest of sorghum. However this insect can be inexpensively controlled with one application of carbaryl (0.75-1.0kg a.i./ha) when 1 larvae/2 plants occurs. The Asian corn borer Ostrinia furnacalis is the most serious postvegetative pest of corn. Carbofuran granules (0.5-1 kg a.i./ha) applied in the whorl is the current recommended practice to control first generation corn borer. Insecticide application with knapsack sprayers is cumbersome because of tall plants and few farmers are willing to adopt this method of control. Most of the recommended insecticides are quite toxic and farmers are afraid to use them. There is scope for the controlled droplet applicator using safer insecticides than carbofuran. Insecticide timeing for corn borer should be based on economic thresholds, which are now being developed. Populations of corn borer can be reduced by cultural and biological means -- intercropping, early-maturing varieties, reduced nitrogen fertilizer, and earwig predators.

8P,11 GENTIAN WITCHES' BROOM ——ITS VECTOR AND HOST RANGE.

Orita, S., Koike, K. and Okuda, S. (Aino Potato Branch, Nagasaki Agr. Forest. Exp. Sta., Aino, 854-03 Japan)

Gentian witches' broom caused by mycoplasmalike organisms (MLO) was first described in 1971. The desease is transmitted by the leafhopper, Scleroracus flavopictus (Ishihara). It can also transmit (Japanese) aster yellows, potato witches' broom, and aromatic geranium witches' broom. After the latent period in the leafhopper, about 20 days, it can inoculate MLO until death. It repeats 3 generations in west Japan ; 2 generations in north Japan and hibernates at the egg stage. The developing periods of the egg are 7 to 10 days, 10 to 20 days, and 19 to 39 days at 30°, 25°, and 20°C, respectively, and adults emerge 26 to 31 days at 25°C. Host plants of the leafhopper are aster, lettuce, gentian, clover etc., however, grasses and tomato are not suitable. It has been found that 20 species in 10 families were infected with MLO near the desease-infested gentian cultivation, among them to 11 species in 7 families such as straw flower, aster, cosmos, lettuce, tomato, carrot, red clover, Japanese radish etc. gentian witches' broom agent was transmitted by the leafhopper. For control of the leafhopper disulfoton and fenthion are available but carbaryl and BPMC have few effect.

8P,12 COMPARISON OF THE OCCURRENCES OF THE BROWN PLANTHOPPER, NILAPARVATA LUGENS (STÅL)(HOM., DELPHACIDAE), DETERMINED BY ELECTRIC LIGHT TRAP, AIR-BORNE NET TRAP, YELLOW-PAN WATER TRAP, VISUAL COUNTING, AND SWEEPING NET METHODS IN JAVA, INDONESIA.

Mochida, O. (IRRI-CRIA, Sukamandi) and Tatang, S. (CRIA, Sukamandi, Kab. Subang, West Java, Indonesia).

It is very important how to estimate the population and the seasonal occurrence of N. lugens, one of the most important insect pests on rice in Indonesia now. Electric light traps with 60-watt bulbs were settled at two locations, whereas air-borne net traps (0.75 m in mouth diameter, 6 m above the ground) and yellow-pan water traps (0.6 m in diameter) were done at four locations in Java from 1975 to 1979. Both visual counting and sweeping net methods were used at not only four locations but also other sites in Java. The seasonal occurrence of the adults shown by one method was correlated in number to those done by other methods. Electric light trap is the best way for estimating the seasonal occurrence in general, but other methods can be used according to the purposes of studies, and natural and social situations.

8P,13 EFFECT OF PHOTOPERIOD ON THE PRODUCTION OF SEXUAL FORMS IN LIPAPHIS ERYSIMI.

Murai, T. and Kawada, K. (Izumo Plant Prot. Res. St., Izumo-shi Shimane Prefecture, 639 Japan)

Field observation from 1976 in the Saigo district showed that sexual forms of Lipaphis erysimi were found on mid-October. According to experimental study, the production of sexual forms was induced by placing grandmother and mother in a day length less than 13.5 hours at 20°C, and was promoted by lower temperature. The sequence of progeny showed such a specific pattern that males were produced after some females and subsequently females were produced again. Sexual forms were produced by even two short-day treatments (8L16D) just before the birth of the mother.

8P,14

APTEROUS MALES AND HOLOCYCLIC REPRODUCTION OF LIPAPHIS ERYSIMI IN JAPAN

KAWADA,K.and Murai,T. (Inst.Agri.Biol.Sci.Okayama Univ.and Izumo Plant Prot.Res.St.)

The turnip aphid, Lipaphis erysimi Kaltenbach is a destructive pest of cruciferous crop. However, the complete life cycle of this aphid has not yet been described.
The holocycle of Lipaphis erysimi was first observed at Saigo in Japan. Oviparous females and apterous males were found on October 14, 1976. A few days after mating, They laid eggs on the radish leaves usually along veins. Fundatrix larvae hatched from the eggs were first observed on April 5, 1977. The fundatrix adults began to produced thier offspring toward the end of April, and parthenogenetic reproduction lasted untill September or some cases October.

8P,15

HELIOTHIS ZEA AND H. VIRESCENS PHEROMONES: BEHAVIOR ELICITED AND POTENTIAL AS CONTROL AGENTS.

Sparks, A., Raulston, J., Lingren, P., and Carpenter, J. (USDA-SEA-Tifton, GA 31794)

The sex pheromones of Heliothis zea (Boddie) and H. virescens F. were identified and field verification of structures were confirmed in 1978. The H. virescens sex pheromone is a combination of 6 aldehydes, 4 of which comprise the H. zea pheromone, and one alcohol. Field tests in Tifton, Georgia, and Brownsville, Texas, in the U.S.A. have explored the behavior elicited by these compounds as well as their potential as control agents. Results of 1979 and 1980 field tests will be discussed.

8P,16

MEOTHRIN - A NEW PYRETHROIDAL ACARICIDE - TRIAL RESULTS FROM SOUTH AFRICA

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Silverton : 0127 - South Africa)

Meothrin (common name Fenpropathrin) which is chemically known as - cyano-3 phenoxybenzyl 2,2,3,3,-tetramethyl cyclopropanecarboxylate, is a new pyrethroidal acaricide/insecticide discovered and developed by Sumitomo Chemical Co. In trials done by Agricura, on Apples, Pears and Cotton in South Africa, it was found that the compound is highly effective against Tetranychus cinnabarinus; resulting in a residual action on Apples and Pears of up to 7 weeks with concentrations ranging between 0,01% a.i. and 0,02% a.i.

8P,17 Synthetic sex pheromones in control of Oriental Fruit Moth in the USSR

Smetnik A.I. All-Union Research Institute for Plant Quarantine, Moscow

In the USSR pheromones of oriental fruit moth are used with the purpose of establishing the area fo the pest, flight dynamics, generation number in different agroclimatic zones and directly to control of pest. Scecificity of different components of the mixture of synthetic sex pheromones was studied. It is determined that the addition of dodecyl brings the attractiveness of Grapholitha funebrana Treit. lower. For the control of oriental fruit moth rubber rings with the 3-component mixture of pheromone are used. The application of these means will make it possible to protect the peach in the industrial orchards. So, while applying one rubber ring per tree in statefarm Abinsky in Krasnodar region the damage of the yield in the case was 1% and in in the check it was 59%. Male anihilation technique was used in the districts of southern and west Ukrain. The results allow to ascertain that the application of 1 or 2 traps per 10 or 20 trees in the plots of land attached to the house makes it possible to reduce the damage up to 1-2% (in the check - 70-90%).

8P,18 ULTRASTRUCTURE OF CUTICLE AND EPIDERMIS OF GALLERIA MELLONELLA LARVAE: CHANGES ASSOCIATED WITH MOULTING AND DIFLUBENZURON EFFECT.

Hegazy, G. and Degheele, D. (Fac. Agricultural Sciences, Coupure 533, B-9000 Gent, Belgium).

The cuticle of the sixth and seventh intermoult larvae of Galleria mellonella possess three clearly distinguishable layers: the trilaminar cuticulin, the protein epicuticle and the lamellar procuticle. At the end of the intermoult the amount of rough endoplasmic reticulum in the epidermal cells is increasing, the microvilli are declining, then partly disappearing and in these parts ecdysial droplets are deposited. The digestion of the old procuticle and the formation of the three layers of the new cuticle are comparable to those in some other larvae. In contrast, the synthesis of vesicles during secretion of the laminated procuticle continues.

Injection of 1 ul of 10,000 ppm diflubenzuron (DFB) into 48 hrs old sixth instar larvae causes inhibition of the cuticular chitin synthesis. Electron microscopy revealed the formation of a new cuticulin and protein epicuticle 60; 72; 84 and 96 hrs posttreatment. After DFB administration apolysis is not followed by a digestion proceeding towards the outer side of the old procuticle and by the formation of an ecdysial membrane, usually formed from the inner zone of the old procuticle onward. Vesicles and microvilli are formed the normal way; however the procuticle has no oriented laminae of chitin fibers.

8P,19 DISRUPTION TECHNIQUE TO CONTROL ORCHARD PESTS (Laspeyresia pomonella and Adoxophyes orana)

- CHARMILLOT Pierre-Joseph, Station fédérale de recherches agronomiques de Changins CH-1260 Nyon (Switzerland)

In Switzerland disruption technique is experimentally applied over many hectares of apples orchards to control Codling moth (Laspeyresia pomonella L.) since 1976 and (Adoxophyes orana) since 1978. For codling moth, the dispensers used are rubber tubes full or impregnated with E_8-E_{10} dodecadien-1-ol. For Adoxophyes, the dispensers consist of polyethylen tubes impregnated with the two components of the pheromone (9 parts Z-9-TDA and one part of Z 11 TDA). For both species, a fence of dispensers is disposed all around the orchard with one source of attractant every 5 m. Inside the orchard, we use one dispenser for 200 m2 for Codling moth and one for 50 m2 for Adoxophyes. The amount of attractant used is 10 g per ha and season for Codling moth and 3 to 4 g per ha and flight period for Adoxophyes. The efficiency of disruption is measured by inhibition of captures in sex traps by inhibition of copulation by tethered females, by the sampling of damage on fruits and sheets during the season and at harvest and by the estimation of surviving population.

8P,20

INSECTS AND MITES OF THE DATE PALM IN THE EASTERN PROVINCE OF SAUDI ARABIA

Hammad, S.M.; Kadous, A.A. and Ramadan, M.M. (Plant Protection Department, King Faisal University, Al-Hassa, P.O. Box 420, Saudi Arabia.)

In the Eastern Province of Saudi Arabia, 42.22% (of 8 Millions) of date palms of the Kingdom are cultivated. Dates are considered the main source of income for Saudi farmers. Such palm trees are infested by various insects and mites. As a result the production of dates is deteriorating. A survey of these pests is investigated to assess the damage they cause. In addition, the ecology and bilolgy of some of these pests are being investigated.

8P,21

TURFGRASS-INJURING INSECTS INVADING JAPAN

Yoshida, M. (Dep. Ent., Shizuoka Univ., Shizuoka, 422 Japan)

In recent Japan, green business for environmental improvement and construction of sports grounds, especially golf courses, are creating large demand for turfgrass.

In 1964, Tifton 328 and 419 were first imported into Japan from Tifton City, Georgia. Along with these turfgrasses, the following three species of turfgrass-injuring insect has invaded Japan, thus causing the present serious damage of turfgrass.

1. Bluegrass webworm, Pediasia (Crambus) teterrellus Zincken (Shibatsutoga) — has inflicted damage on turfgrass (Zoysia tenuifolia) since 1968. Control of this insect has been made at a vast cast every year. In 1978, high temperature and few rainfall in the summer extended damaged areas with damage of 200 million yen in some golf course.
2. Rhodesgrass scale, Antonina graminis Maskell (Chigaya-shiroo kaigarmushi) — has damaged turfgrass since 1970.
3. Hunting billbug; Sphenophorus venatus vestitus Chittenden (Shibaosazoumushi) — has damaged turfgrass since 1977. The damage by this insect has been confounded with damage by grub larvae.

This paper describes details of the damage and the method of controlling the above insects.

8W-1,1

ASSESSING THE POTENTIAL OF ALIEN PESTS.

Baker, C.R.B. (MAFF, Harpenden Laboratory, Harpenden, England)

An immense number of phytophagous insect species could be introduced into and damage crops in areas from which they are now absent. Plant quarantine regulations cannot be framed to exclude all alien species from a particular area without disrupting international travel and trade. Selection of the more important species is not simple. An approach to making such a selection is outlined in this paper. It starts from known hosts and geographical distribution and proceeds, where relevant information is available to estimation for the new area of the probable annual life cycle, natural mortality levels and pest status. The likely costs of control and other measures can then be set against the costs of attempting to exclude the species.

8W-1,2 MEASURES TO EXCLUDE COLORADO BEETLE FROM THE UK.

Bartlett, P.W. and Baker, C.R.B. (MAFF, Harpenden Laboratory, Harpenden, England)

Legislation to prevent the entry of Colorado beetle (*Leptinotarsa decemlineata* (Say)) has been in force in the United Kingdom for over 100 years. Since the first beetle was found in 1877 beetles have been found in most years but breeding colonies have occurred in only 15 years and have been eradicated successfully. The measures taken include inspection and control of imports, extensive publicity and official eradication of colonies. The effectiveness of these measures is discussed in relation to the suitability of the environment in Britain for Colorado beetle.

8W-1,3 THAI POLICY OF PLANT QUARANTINE.

CHETTANACHITARA, C. (Agric. Reg. Div., Dept. of Agric., BANGKOK-9, THAILAND)

Thailand is an agricultural country. Major crops are rice, sugar-cane, corn and etc. which are being exported to various destinations. To prevent the introduction of exotic plant pests, Thai government had constituted the Plant Diseases and Plant Pests Prevention Act B.E.2495 that has been taken place by the Plant Quarantine Act B.E.2507. According to the act, prohibited PQ-objects can't be brought into the Kingdom except for research purposes and a permit must be obtained prior to introduction; restricted plants must be accompanied by a phytosanitary certificate; non-restricted plants must be declared at the port of entry; and exported consignments will be certified, if the exporters request for phytosanitary certificates. For international co-operations, Thailand is a member of the International Plant Protection Convention, the Plant Protection Committee for the South East Asia and Pacific Region and others.

8W-1,4 INSECT PESTS OF QUARANTINE CONCERN IN THE UNITED STATES.

Chilson, L.M. (Regulatory Entomology Consultant, Silver Spring, MD., 20904, U.S.A.)

A small percentage of the total number of pests of crops and forests in the world are established in the United States. Because of the country's diverse climate and the variety of crops, the U.S. plant quarantine service is concerned with all potential pests from all foreign agricultural and forest regions. A list of all such pests would be enormous and require constant maintenance. The plant quarantine service utilizes a method of determining pests of quarantine concern based on more than 70 years of experience. Pests are evaluated by degrees of risk or potential for establishment and their economic importance. Regulatory action is taken proportionate to the risk, the current level of knowledge of the pests' behavior, and the changes in treatment capability, economics and public acceptance. The probability of soybean pests becoming introduced is discussed in some detail as an illustration of the method used to evaluate and reduce the risk of their establishment.

8W-1,5 THE INDIAN LAC INSECT IN TAIWAN, ONCE A BENEFICIAL INSECT, NOW A NUISANCE. Hsieh, F. K. and Hwang, J. S. (Plant Protection Center, Taiwan, Wufeng, Taiwan 431, R.O.C.)

Fifty eight species plants were found to have damaged by the lac insect, Kerria lacca Kerr in Taiwan. Damage rates of two most seriously injuried fruit trees, longan and lichee were 26.6 and 9.1%, respectively. Two generations were found to occur each year. Overwintering was performed by the adult. Eggs were formed in the female adult yet ovoviviparity was evidenced. The first instar stuck to the tree branch at the end of its stadium and thereby parasitized the host for good. Secretions of wax and shellac began in the first instar and continued to increase till the adult stage. The female possessed 3 nymphal stadia but the male had only 2 with additional prepupal and pupal stages. The female remained on the branch all its life whereas the male emerged to either winged or winglessed forms. The insects tended to shelter themselves underneath the branches to avoid the solar radiation and rainfall. Dispersal were carried out by self-movement of the crawling first instar, wind, birds, and other animals. Susceptibility of the insect among various varieties of longan and lichee showed no significant difference. Several natural enemies were identified and the symbiosis between the lac insect and the ant usually occurred. Experiments in the green house showed that emulsive spraying over the tree was more effective against the insect than granular treatment of the root zone or painting chemicals on tree trucks or branches. A complete control was obtained in a few weeks following a single spray of the nymphal stadia with dimethoate, azodrin, anthio, or dimethoate + summer oil. However, the best control reached only 69.4% (anthio) when the spray was directed towards the late adult stage 4 times at a 2-week interval.

8W-1,7 Korean Policy of Plant Quarantine, Ki Yull, Yu (N.P.O. Anyang-city Kyunggi-do 171 Korea)

Our policiy of plant quarantine is as follows;

1. Improvement of inspectors quality
   1) The training in domestic and foreign institutes pertinent will be provided to inspectors.
   2) We will call in specialists concerned, and will learn new knowledge and advanced technology from them.
2. Activation of research works
   1) Pests and diseases in our country and abroad will be surveyed. 2) We will survey the situation of pests and diseases from owerseas, and the integrated control measures for eradicating them will be studied and established.
3. Research and development of inspection and disinfection methods.
   1) We will make efforts to establish the efficient inspection and disinfection methods for each plants, each pests or diseases, including development of the suitable fumigants or pesticides.
   2) We will take steps to reinforce facilities and equipments for inspection and fumigation.
4. Promotion of institutional and international cooperation.

8W-1,8 THE PLANT QUARANTINE THREAT FROM OFFSHORE STATES: HAWAII AND THE CONTINENTAL UNITED STATES. Shannon, M. J. (Plant Protection and Quarantine, Hyattsville, Maryland, U.S.A.)

The Hawaiian Islands, though politically a part of the United States, are in terms of their pests and pathogens an exotic area. These islands are more susceptible to invasion and establishment as borne out by pest and pathogen introduction records. Quarantine interceptions and mainland pest establishment records show that Hawaii poses a unique threat to U.S. mainland agriculture as a transit point for pest invasions. Federal quarantine measures are a barrier to these invasions.

8W-1,9 ENTOMOLOGY AND PLANT QUARANTINE IN NEW ZEALAND

Somerfield, K.G. (Plant Health Diagnostic Station, M.A.F., Lincoln, New Zealand.)

The history of insect quarantine interceptions in New Zealand is outlined from the earliest records of T.W. Kirk (published from 1884) to the present day. Entomological aspects of New Zealand plant quarantine policy are currently administered under the terms of the 'Plant Act 1970' and 'The Introduction and Quarantine of Plants Regulations 1973'. Current restrictions on imports are reviewed.

Important plant species at risk from new pests are ryegrass (*Lolium* sp.), clover (*Trifolium* spp.), lucerne (*Medicago sativa* (L.)), cereals (including maize (*Zea mays* L.)) and apples (*Malus pumila* Miller). Several species of scale insects which are frequently intercepted may collectively be a risk to the New Zealand citrus industry. Many important overseas pests are not yet established in New Zealand; other countries with temperate climates are a possible source of pests preadapted to the New Zealand climate. Particular importance is attached to pests which are polyphagous, parthenogenetic, or transmit virus and other diseases. Frequency of interception of insects and mites is detailed on a pest, country of origin, and host basis. Details are given of some important potential pests, and pests recently recorded within New Zealand.

8W-1,10 THE ESTABLISHMENT OF A LIST OF QUARANTINE PESTS IN JAPAN

Sonda, M. and Watanabe, N. (Div. Ent. and Nema. Yokohama Plant Prot. Station, MAFF, Yokohama 231 Japan).

Plant quarantine is administered in Japan since 1914. Insect pests of quarantine concern fall under three categories. First, there are the designated insects the import of host plants of which is law-prohibited. Secondly, there is a group of insects which are considered to be important next to the above. Thirdly, there are insect pests other than the two.

When preparing the list, the following three major factors are considered.

1) The species are pests of host plants of highly economic importance.
2) The species are likely to cause extensive damage to host plants and plant products.
3) The species have potential to establish themselves in Japan.

Section 9.

Forest Entomology.

9S-1,1 PHEROMONE COMMUNICATION MECHANISMS OF THREE SYMPATRIC PACIFIC COAST AMBROSIA BEETLES.

Borden, J. H., (Pestology Cent., Dept. Bio-Sci., Simon Fraser Univ., Burnaby, B.C., Canada, V5A 1S6)

The aggregation pheromones for *Trypodendron lineatum*, *Gnathotrichus sulcatus* and *G. retusus*, respectively are 3,3,7-trimethyl-2,9-dioxatricyclo-$[3.3.1.0^{4,7}]$ nonane (lineatin), a 65:35 mixture of S-(+)- and R-(-)- 6-methyl-5-hepen-2-ol (sulcatol) and S-(+)-sulcatol. Both enantiomers of sulcatol are required to induce response by *G. sulcatus*. Response occurs when as little as 1-2% of R-(-)-sulcatol is mixed with S-(+)-sulcatol, and is optimal at ratios of S-(+)- to R-(-)-sulcatol ranging from 75:25 to 25:75. *G. retusus* responds to S-(+)-sulcatol, and response begins to be inhibited as soon as a small amount of the antipode is present. Thus, *G. retusus* is probably excluded from *G. sulcatus* habitat by the inhibiting action of R-(-)-sulcatol. *T. lineatum* responds to (+)- or (±)-lineatin, as the (-) enantiomer is inactive. Response is not inhibited by the pheromone of either *Gnathotrichus* species, with which it can share the same host. The response of *G. retusus* to S-(+)-sulcatol is synergized by ethanol, while male *G. sulcatus* response is synergized by ethanol and α-pinene. The response of *T. lineatum* to lineatin-baited, wire mesh, sticky traps is partially inhibited by ethanol, with or without α-pinene, but in Europe, ethanol and α-pinene are effective synergists in traps which present a prominent; dark, vertical silhouette. The interaction between pheromones, synergists and traps must be evaluated before lineatin can be combined with either S-(+)- or (±)- sulcatol in a pheromone-based pest management program.

9S-1,31 SONICALLY INDUCED BEHAVIOR AND MULTIFUNCTIONALITY OF PHEROMONES IN *DENDRONCTONUS* BARK BEETLES.

Rudinsky, J.A.(Dept. Entomology, Oregon State University, Corvallis, OR 97331 USA)

The behavioral chain of North American *Dendroctonus* involves an interaction of sonically and chemically induced stimuli and responses that depend upon both qualitative and quantitative factors, i.e. upon both the acoustic parameters of stridulation or the chemical composition of the pheromone and upon the number of these signals. Acoustic analysis of individual chirps shows that stridulation in response to attractants signals arrival for cooperation (mating) or competition (sexual or territorial); and it triggers further release of pheromones that by their kind and/or quantity stop flight aggregation and affect the pairing behavior of aggregated individuals near the gallery. Substances found to have concentration-dependent multifunctional effects include 3-methyl-cyclohex-2-en-1-one (3,2-MCH), its isomer 3-methylcyclohex-3-en-1-one (3,3-MCH), *exo*- and *endo*-brevicomin, verbenone, and perhaps *trans*-verbenol. The multifunctionality of verbenone with *D. frontalis* in Texas has been tested by the electroantennogram and single-cell techniques as well as standard bioassays using olfactory and auditory responses; parallel electrophysiological tests with *D. pseudotsugae* in Oregon are underway. Data will be given from current research on several of the most destructive *Dendroctonus*, including *D. ponderosae* on three host tree species in Oregon.

9S-1,2 "*SCOLYTUS MULTISTRIATUS*": ITS BIOLOGY AND PHEROMONE APPLIED TOWARDS REDUCTION OF DUTCH ELM DISEASE.

Lanier, G. and Simeone, J. (Dept. Environ. & Forest Biol., SUNY Coll. Environ. Sci. & Forestry, Syracuse, N. Y. 13210, U.S.A.).

Declining rate of Dutch elm disease in isolated groves of American elm were coincident with mass trapping the disease vector, *Scolytus multistriatus*. Effectiveness of sticky traps baited with the aggregation pheromone, Multilure, increased as the number of competing natural pheromone sources (disease elm wood infected by female *S. multistriatus*) decreased.

In another experiment diseased and unwanted elm trees were used as tree traps by baiting with Multilure and killing them with an herbicide that induced rapid drying of the bark so beetle broods failed to mature.

9S-1,3 THE EVOLUTION OF CHEMOSENSORY SPECIFICITY AND DIVERSITY IN *IPS*.

Birch,M.C. (Dept.Ent.,Univ.California,Davis,CA95616,USA)

The aggregation pheromones of N. American *Ips* species are composed principally of one or more of the enantiomers of ipsenol and ipsdienol, possibly also either *cis* or *trans*-verbenol or both, and may also be enhanced in combination with terpenes released from the host tree. The evolution of known single and multi-component pheromone systems in these species will be discussed in relation to species distribution, to the degree of relatedness and interspecific attractiveness of sympatric (inhabiting the same host tree) and allopatric species, and to the interspecific behavioural interactions between cohabiting and potentially cohabiting species during the process of colonizing the host material. The thesis will be drawn from the results of behavioural and electrophysiological experiments on *Ips* species from California and Texas.

9S-1,4 INFLUENCE OF INHIBITORS ON SOUTHERN PINE BEETLE BEHAVIOR.

Payne, T. L. (Dept. Ent., Texas A&M University, College Station, TX 77843, USA)

The southern pine beetle, *Dendroctonus frontalis* Zimmerman (Coleoptera: Scolytidae), is known to be influenced by at least two inhibitors, *endo*-brevicomin and verbenone. Behaviorally, each pheromone alone reduces the response of both male and female beetles to sources of attraction. When combined, the effect of both compounds is greater than either alone. At the receptor level, both inhibitors are found to interact with olfactory acceptors for the beetles' primary attractant pheromone, frontalin. The level of interaction is different between males and females. Electrophysiologically, verbenone was found to inhibit attractant-stimulated muscle potentials in the beetle. Both compounds have potential for use in manipulating pest populations of *Dendroctonus frontalis*.

9S-1,5 SECONDARY ATTRACTION OF THE EXCRETA OF MALE PHLOEOSINUS ARMATUS. THE EFFECTS OF DIGESTIVE TUBE BACTERIA ON TERPENOIDS.

Chararas,C., Oucauze,C., Rutledge,D., Cazelles,M.T.
Institut National Agronomique 16, rue Claude-Bernard 75231 Paris-Cedex 05.

The bark beetle *phloeosinus armatus* is found only in a limited number of countries (Greece, Turkey) and shows a specifity for *Cupressus*.Primary attraction experiments on *Cupressus* phloem extracts have demonstrated a positive orientation for both male and female insects, whereas other Conifer extracts (*Pine*, *Abies*,*Picea*) show no strong attractive effect : 62% of the insects are attracted by the *Cupressus*extract only, the remaining 38% show at first a temporary attraction towards the other extracts.
As well, the male *phloeosinus armatus* exerts a secondary attraction on the female and we have shown that a hexane extract of male frass produces a very strong attraction (77%). This attraction results from the presence of vegetal substances metabolized by mid-and hind- gut secretions and also from compounds produced by the action of intestinal bacteria on terpenoîds. We have, in fact, isolated and purified one type of enterobacteria which was characterized and grown on a culture medium containing papaînic soya pepton glucose and different terpenes. By GLC and HPLC we have demonstrated the apparition of new compounds of which we are determining the structures and attractive effects.

9S-1,6 SEXUAL DIVISION OF LABOR IN REPRODUCTIVE BEHAVIOR, ESPECIALLY THE TRANSMISSION OF MUTUALISTIC FUNGI BY AMBROSIA BEETLES.

Nakashima, T. (Dept. Agric. Biol., Hokkaido Univ., Sapporo, 060 Japan)

Ambrosia beetles, both adults and larvae, feed on their mutualistic fungi (ambrosia fungi) cultivated in their galleries. The parent beetles, therefore, have many works such as transmitting the mutualistic fungi, boring galleries, cultivating the fungi, cleaning and ventilating the galleries, etc., to take care of their offspring. The sexual division of the works differs according to the sex ratio of the parents, namely monogamy and polygamy. In addition, it seems that the galleries also differ in type according to the sex ratio. All this is shown here for some twenty species of Scolytid and Platypodid ambrosia beetles.

9S-1,7 CURRENT KNOWLEDGE ON THE INTERRELATIONSHIPS BETWEEN THE SOUTHERN PINE BEETLE AND ASSOCIATED MICROORGANISMS.

Barras, S. and Bridges, J. (USDA Forest Service, Washington, D.C.)

The southern pine beetle (SPB), (*Dendroctonus frontalis* Zimm), and its associated microbial complex are a major pest of *Pinus* spp. in the southern United States. The SPB transports microorganisms in these ways: in an ectodermal mycangium (=mycetangia), on phoretic mites, on the body, and within the intestinal tract.

The following organisms are found in the mycangium: A *Sporothrix* sp.; an unknown Basidiomycete; and yeasts, *Hansenula holstii* Wickerham and *Picea pinus* (Holst) Phaff. Absence of these and other microbes results in a significant decrease in beetle development in the laboratory. Volatile metabolites of the yeasts greatly enhance the attractiveness of a standard attractive mixture to walking beetles in the laboratory. Phoretic mites, *Tarsonimus ips* and *T. krantzi* are hyper-vectors of *Ceratocystis minor* (Hedgc.) Hunt, a blue stain fungus which probably aids the complex through a pathogenic action on the tree. Direct feeding of the SPB on *C. minor*/phloem mixture, however, is detrimental to the insect. A myriad of other filamentous fungi, yeasts and bacteria are associated with the SPB in its intestinal tract and galleries at various stages of development. The components of this ecosystem are so interdependent that the term "ecological superorganism" is appropriate. The insect has been reared successfully in vitro without microorganisms.

Some major questions still remaining to be answered are: (1) What is the controlling mechanism for function of the gland cells and the chemical nature of secretions in the mycangium? (2) What is the complete chemical bouquet produced by microbes associated with the SPB and how is SPB behavior, both outside and inside the tree, affected? and (3) What specific nutritional interdependencies are there between SPB and the ambrosial growth of the mycangial fungi in the larval galleries?

9S-1,8 ECOLOGY AND NUMBER DYNAMICS OF IPS SUBELONGATUS MOTSCH POPULATIONS IN LARCH WOODS OF SIBERIA.

Isaev A.S. (Inst.Forest and Wood Sib.Br.USSR Ac.Sci., Krasnoyarsk, 660036, USSR)

The factors of the Siberian larch resistance to bark beetles and behavioral reactions of insects ensuring the choice of optimal foodstuff are considered. The tree primary attractivity and the influence of the pheromones of the bark beetle attractants are shown to lead to high concentration of beetles on weakened trees, to regulate the mating and the settlement density. Landscape-ecological distribution of populations, weather conditions, the role of entomophagous insects and microorganisms in regulation, intraspecific and interspecific relations are taken into account in analysing the bark beetle number dynamics. The main indicators to forecast mass propagation of bark beetles are singled out. The possibility to model the bark beetle number dynamics according to the principle of the dynamic ecological system stability is discussed.

9S-1,9

ECOLOGY OF TROPICAL BARK AND AMBROSIA BEETLES. Beaver, R.A. (Dept.Biol., Univ.Zambia, Lusaka, Zambia)

Moist tropical forests have large numbers of species of Scolytidae and Platypodidae, with a high proportion of ambrosia beetles. The beetles attack dead (and sometimes living) woody stems of all sizes, fruits and seeds, and even leafstalks. Tropical forests show high tree diversity and rapid decay processes. Suitable breeding material in the natural forest is widely scattered in space and only available for a short time. Host location and host specialisation are more difficult for the beetles than in temperate forests. The apparent heterogeneity of the forest to the beetle can be reduced by polyphagy. Phloeophagous species are less host-specific in the tropics than in temperate regions. Xylomycetophagous species show a similar low host-specificity in both regions. Where host specialisation has evolved, it is usually on tree families with a high 'apparency' to the beetles, either because they are abundant or because they produce resins and aromatic oils.
Spanandry is common in tropical Scolytidae. It facilitates colonisation of scattered host material while simultaneously increasing the biotic potential, but may only be advantageous if juvenile mortality is low. Spanandry also promotes speciation since it is associated with sib-mating and the production of numerous genetically isolated clones, and with haplodiploidy. If aggregation pheromones are produced by spanandrous species, they could be used to attract close relatives to a breeding site.
Species coexistence is aided by differences in feeding habits, and host and size preferences, but there is much niche overlap. Competitive exclusion may not occur due to the patchy occurrence of breeding sites, coupled with the need for dispersal in each generation to find these sites. This gives opportunities for fugitive strategies. 'Founder effects' may also be important.

9S-1,10

THE CORRELATION OF BIOLOGY AND BEHAVIOR WITH CLASSIFICATION AND PHYLOGENY IN SCOLYTIDAE. Wood, S. L. (Life Sci. Mus., Brigham Young Univ., Provo, Utah 84602, U.S.A.)

Mutualistic relationships between Scolytidae and fungi may be universal; however, the ambrosial habit has arisen in only 8 of 28 tribal groups along 7 independent phyletic lines. Of equal or greater interest to classification and phylogeny is a diversity of mating systems that includes monogamy, heterosanguineous polygyny, consanguineous polygyny, and gynogenetic parthenogenesis. These habits, coupled with aggregation and courtship behavior, make possible refinements in scolytid classification that apparently reflect genuine phylogenetic relationships. An appreciation of the meaning of these relationships should enhance the research of all who work with these insects.

9S-2,11

SIMULATION ANALYSIS OF THE ENVIRONMENTAL RESISTANCE TO FOREST INSECTS. Fukuyama, K. and Yamaguchi, H. (Hokkaido Branch, For. & For. Prod. Res. Inst., Sapporo, 061-01 Japan)

Most of the outbreaks of forest insects have been occured in wide and simple man-made forests, because the environmental resistance in these forests is weaker than natural and mixed forests. Pest control method through silvicultural treatments, therefore, has to be built up on the basis of the informations about the environmental resistance to the endemic forest insect population and simulation analysis is one of the effective methods for this purpose. We will deal with a case study on gypsy moth. The procedure is;

(1) Introducing artificial population in forests under various conditions.
(2) Analysing the mortality factors on the populations
(3) Interpreting effcts of the mortalities by means of simulation models.

9S-2,13 FOREST INSECT PROLEMS IN INDONESIA

F. Gunarwan Suratmo (Fac. For., Bogor Agr. Univ., Bogor, Indonesia)

Some forest insects have been reported as general pests in Indonesia and some of the forest insects are in the category of dangerous forest pests. Based on their host trees those pests are : Xyleutes ceramica Walker, Phassus signifer Hampson, Hyblaea puara Cramer, Hapalia machoeralis Walker, Xyleborus destruens Blandford, Neotermes tectonae Damm and Coptotermes curvignathus Hoiver in Tectona grandis plantation ; Millionia basalis Walker, Dioryctria rubella Hampson, Eumeta spp and Evetria spp in Pinus merkusii plantation ; Hypsipyla robusta (Moore), Xyleborus compactus Eichhoff in Swietenia spp plantation ; Xystrocera festiva Pascoe, Eurema spp and Zeuzera coffeae Neitner in Albizia falcataria plantation. Research and pest control activities are far from sufficient. The research activities have been marked by discontituity and not intensive enough. Industrial forest plantations are being established with monoculture forest type in very large hectarage. This also means that the possibilities of explosions of pest populations are increasing. Trial planning of some tree species including exotic ones in East Kalimantan have been infested seriously by some local forest insects.

9S-2,14 PROSPECTIVE INTEGRATED PEST MANAGEMENT OF SLASH PINE ECOSYSTEMS IN FLORIDA.

Wilkinson, R. C. and Schmidt, R. A. (Dept. Ent. & Nem., Univ. Florida, Gainesville 32611 USA).

In Florida more than 2 million ha of slash pine (Pinus elliottii Engelm. var. elliottii) are intensively managed for fiber production. Vulnerability of this monoculture to sporadic outbreaks and major epidemics of native pests such as scolytid bark beetles and fusiform rust (Cronartium quercuum f. sp. fusiforme) has increased. Interactions between fusiform rust and pest populations of Dioryctria coneworms, Hylobius and Pachylobius reproduction weevils, Pissodes nemorensis Germar, and Ips spp. pine engraver beetles are discussed in relation to pest management strategies.

9S-3,15 MATSUCOCCUS FEYTAUDI DUC.(HOMOPTERA-MARGARODIDAE) A DANGEROUS SCALE-PEST OF MARITIME-PINES (PINUS PINASTER AIT) IN THE WESTERN MEDITERRANEAN COUNTRIES.

Schvester D. Carle P. Fabre J.P. Riom J. St. Zoo. Avignon.I.N.R.A. France.

The introduction of Matsucoccus feytaudi on Pinus pinaster in the French South-Eastern mediterranean region, resulted in the decay of important areas of Pine stands.Bionomics of the Coccid. Population dynamics and factors affecting them in different regions of France. The role of Matsucoccus and of xylophagous insects, especially Bark-weevils in the process of the decay. Description of the evolution of stands and tentative analysis of factors affecting them. Possible control and management measures proposed.

9S-3,16

THE SIREX PROBLEM IN RADIATA PINE PLANTATIONS OF SOUTH-EASTERN AUSTRALIA.

Neumann, F. G., Minko, G. (Forests Commission, Victoria, Melbourne, 3001 Australia) and Tanton, M. (Dept. Ent., Australian National University, Canberra, ACT 2600 Australia)

Sirex noctilio with its pathogenic obligatory symbiont *Amylostereum areolatum* is economically the most serious introduced pest within the extensive exotic radiata pine plantations in Tasmania and Victoria. Some stands of inermediate age and shelterbelts have been devastated. There is concern over the possible spread of the pest into neighbouring South Australia and New South Wales, because geographic and bioclimatic barriers are absent. Life cycles are predominantly of one-year duration. Emergence and attack of adults on pine peak during midsummer, when soil moisture levels and growth rates of pine are declining and susceptibility to the pest is increasing. Introduced rhyssine parasitoids and the nematode parasite *Deladenus siricidicola* have been effective control agents in the generally drought-free Tasmanian plantations. In Victoria, where drought periods are frequent and summers are warmer, ecological balance between host and parasite populations has occurred only after a very high and unacceptable level of tree mortality. A control strategy is being devised that combines the effects of biological control and minimal selective non-commercial thinning with the use of strategically positioned groups of lure trees, produced by injecting systemic herbicide into outer sapwood at the base of stems.

9S-3,17

THE STATUS OF IMPORTANT INSECT PESTS THREATENING NATIVE OR EXOTIC PINES IN SOME TROPICAL AREAS.

Schmutzenhofer, H. (Forestry Research Inst., A-1131 Vienna, Austria)

Pines are now widely planted in the tropics inside and outside their natural range. In dependance of altitude and latitude different pine species are planted and frequently harmed by insect pests. For the neotropic - and the southern parts of the nearctic realm, pests of pines growing or planted in lowlands, medium elevations and highlands are described in detail. Attacking *Pinus caribaea*, *Atta* spp., *Pseudopantomorus latifrons*, Curc.-Brachyderinae and *Neodiprion excitans* are mentioned. An outbreak of *Tropidacris dux*, Saltatoria, defoliating stands of P. *oocarpa* and P. *tenuifolia* (maximinoi) is aswell reported as the geometrides *Glena bisulca* and *Oxydia trychiata* infesting P. *patula* among other pests threatening different pines.

A review of insects threatening pines in other tropical regions is given too.

The possibility and the practicle use of different control measures is discussed and the status of insect pest forecasting is pointed out.

9S-3,18

DESTRUCTIVE INSECT PIESTS OF *PINUS KESIYA* IN THAILAND.

Hutacharern, C.(Div. of Silviculture, Royal Forest Department, Bangkok, Thailand)

Intensive planting of *Pinus kesiya* has been developed in Thailand since 1963. Insect problems were not aware of for many years, later, reports of insect damages to the plantation has been received from different localities. Presented here is the compilation of all insects causing deterioration to *P. kesiya* plantation in Thailand.

Shootmoths,sawflies, gelechiid moth, aphid, midge, bark beetles, white grub, webworm were reported being harmful to pines, and status of damages at present and economic importance in future of them will be discussed.

9S-3,19 Epidemic trend of pine gall midge (Thecodiplosis japonensis) and its control measures in Korea.

KO, J.H. (Forest Research Institute, Seoul, Korea)

The control of pine gall midge (Thecodiplosis japonensis) is a serious problem of the forest protection in Korea. The ecology and the control methods of pine gall midge are as follows.

- o Pine gall midge lays eggs most actively from 6:00 to 7:00 PM, laying all the eggs within a day. The number of eggs laid by one female is about 90, which is about 80% of the eggs in the ovary.
- o The greatest lethality in the crown was in egg stage(23.1%), in the soil, prepupal stage(52.9%).
- o The dispersing direction of pine gall midge infestation is northeast, which coincides with the direction of the prevailing wind during the period of adult emergence. Annual dispersing distance was about 2-4 km.
- o The infestation of pine gall midge becomes heaviest 5-7 years after the occurrence ; and about 10 years after the occurrence, the infestation decreases by dint of the parasites.
- o Insecticides against pine gall midge : NAC 3% D, Dimecron 50% EC, Azodrin 24% LQ, Temik 15% G.
- o Two species of hymenopterous parasites, Inostemma seoulis and Platygaster matsutama, were discovered and their ecological studies have been carried out and mass reared for utilization. -End-

9S-3,20 PINE WILT INVOLVING A NEMATODE, BURSAPHELENCHUS LIGNICOLUS, AND A CERAMBYCID BEETLE, MONOCHAMUS ALTERNATUS.

Mamiya, Y. (For. & For. Prod. Res. Inst., Ushiku, Ibaraki, 305 Japan)

A destructive disease involving the pine wood nematode, Bursaphelenchus lignicolus, and the pine sawyer beetle, Monochamus alternatus, has caused devastating damages to pines (Pinus densiflora and P. thunbergii) in Japan. Newly emerged adult beetles from dead trees carry dauerlarvae nematodes in their tracheae. During maturation feeding of adult beetles on fresh branches of healthy pine trees, nematodes leave the beetle body and enter pine tissues through injuries. Nematode infection occurs through early June to late July. The first symptom of disease is the failure of a tree to exude oleoresin from wounds. The rapid development of disease results in death of pine tree in late August. Huge populations of nematodes build throughout the diseased tree. In wood nematodes occur mostly in axial and radial resin canals where they feed on epithelial cells. Adult beetles oviposit successfully in weakened trees during July to mid August. During February to May, nematodes, the dispersal third stage larvae, gather around the pupal chambers of beetles. In late May aggregated nematodes molt to the dauerlarvae. Just after emerging, adult beetles become contaminated with dauerlarvae. Closely coordinated life cycle of pine wood nematode and pine sawyer beetle causes the pine wilt.

9S-3,21 BILOGY AND CONTROL OF MONOCHAMUS ALTERNATUS HOPE (COL.:CERAMBYCIDAE) IN REFERENCE TO ITS ROLE OF TRANSMITTING THE WOOD NEMATODE, BURSAPHELENCHUS LIGNICOLUS MAMIYA & KIYOHARA (NEMATODA:APHELENCHOIDIDAE), PATHOGEN OF THE PINE WILTING DISEASE.

Yamane, A., Ikeda, T. and Enda, N. (Forestry & For. Products Research Institute, Ibaraki, 305 Japan)

Heavy infestations of pines have been occurring for dacades in the southwestern Japan and are spreading to the norwtheastern districts. Mortality is caused by the wood nematode, which is transmitted by the pine sawyer, M. alternatus. Several species of Scolytids, Curculionids and Cerambycids were thought to be related with pine deterioration, but now most of the pine mortalities are shown to be caused by the wood nematode. From an ecological viewpoint, population dynamics of the beetle and other bark and wood-boring beetles depends on the dispersal and feeding behavior of the sawyer, because the sawyer, completely secondary pest, produces its and their suitable breeding materials, dying pine trees by transmitting the wood nematode. Nematode-sawyer complex often results in annihilation of pine trees within a stand.

To protect pines a new control measure, preventive spray of insecticides to pine stand, is adopted to prevent the sawyer from feeding on the bark of twigs of healthy pines, as transmission and invasion of the nematode to healthy pines is made during the sawyer's feeding. Also researches on development of insect behavior regulating chemicals, attractants to oviposition sites, is undertaking.

9S-4,22 INSECT PROBLEMS OF FOREST PLANTATIONS IN CANADA

SIPPELL, W.L. (GREAT LAKES FOREST RESEARCH CENTRE, BOX 490,
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A recently revealed and sobering forestry statistic that some 12% of the forestland in Canada, or about 28 million hectares, is inadequately stocked with trees, is gradually gaining public attention. Clearly the establishment and maintenance of productive growing stock on this land are vital to the long range economic outlook for forestry in Canada. Protection against plantation insects will be an integral and primary forest management objective.

The array of important plantation insects in Canada based on species of greatest current importance in each region is described as determined by the Canadian Forestry Service through its Forest Insect and Disease Survey group. Component species are classified in various ways and assessed as to their destructive potential. Various pest control strategies as well as priority surveys and research needs suggest themselves.

9S-4,23 THE SUGI BARK BORER, Semanotus japonicus (Cerambycidae), CAUSING "HACHIKAMI" DAMAGE TO JAPANESE CEDAR.

Kobayashi, K. (Kansai Branch, For. & For.Pro. Res. Inst., Fushimi, Kyoto, 612 Japan)

Man-made forests cover 9.4 million ha accounting for about 38 % of the total forest land area in Japan. Japanese cedar (Cryptomeria japonica) is the most widely planted tree species in cool and warm temperate zones and covers more than one third of total plated area. Japanese cypress (Chamaecyparis obtusa) follows it.
The sugi bark borer attacks trunks of both tree species. Japanese cedar is more frequently attacked than cypress. Trees are seldom killed by larval feeding on the phloem and xylem, but the commercial value of the timber is severely reduced by damage called "Hachikami" which is the scars and rot caused by the larval feeding and consequent invasion of wood rotting fungi. Until 1960's this damage was not so severe, but with the increase in cedar planting after the World War II, "Hachikami" has increased greatly and become one of the most important insect problems in western Japan except kyushu.

9S-4,24 ON INSECT PROBLEMS IN MAN-MADE FORESTS OF CHINA.

Xiao, G. (For. Res. Ins., Chinese Aca. For., Beijing, China)

In southern China, a large number of man-made forests have been established. The tree species planted are China fir, Cuninghamia lanceolata, and the massonian pine, Pinus massoniana. In recent years, many insect pests have broken out in these forests. Among the most destructive are the longicorn beetle, Semanotus bifaciatus, and the leaf roller, Polychrosis cuninghamicola, of China fir, and the pine caterpillar, Dendrolimus punctatus, and the pine shoot moth, Dioryctria splendidella, of the massonian pine. The main factors causing outbreaks of these pests are the large acreage of pure stands, the unreasonable planting, and man's activities. Control measures include the establishment of mixed stands, the reasonable planting and management, and the implementation of integrated control taking biological method as foundation and chemical methods as an urgent treatment in order to maintain the pest's population below economically tolerable level.

9S-4,25 INSECT FOOD PLAN SYNCHRONY AS A FACTOR IN THE OUTBREAK DYNAMICS OF PEST SPECIES. Morgan, F. David (Waite Agricultural Research Institute, University of Adelaide)

Forest insects are usually in synchrony with their resources but the degree of that synchrony varies according to key factors that operate independently of insect population density.

Variation in the degree of synchronomy may determine the outbreak dynamics of species especially those which are increasing their host range or those which are capable of influencing the phenology of their food plants. Two examples of such interrelationships are explored, one involving a chewing insect, the other a sapsucker. Two diagramatic models are presented to explain the key interrelationships that govern population densities of the insects upon their food plants.

9S-4,26 INSECT PROBLEMS ASSOCIATED WITH HYBRID POPULUS AND THOSE OF TISSUE - CULTURE ORIGIN.

Benjamin, D.M. and M.O. Harrell. Dept. Ent. Univ. Wisc. Madison - USA

Adult cottonwood leaf beetle, Chrysomela scripta Fab., exhibited a significant feeding preference for hybrid popular (Populus) clones with a Tacamahaca parentage. They displayed a significant nonpreference for one clone with a Leuce parentage, and an intermediate preference for the Aigeiros clones, including those of tissue-culture origin. No ovipositional preferences were observed.

Larvae reared on foliage from Aigeiros clones had shorter developmental times than those reared on Tacamahaca foliage. Those reared on Leuce foliage did not reach maturity. Developmental rates were positively correlated with the moisture content of the foliage consumed, and this probably is related to differences in consumption rate. No differences in prepupal weight or adult fecundity were determined.

An association may exist between the pathogen of an unidentified lethal canker of tissue-cultured hybrid poplars and the poplar and willow borer, Cryptorhynchus lapathi L. The borer produces a wound that could provide the infection court.;

9S-4,27 SURVEYING THE NUN MOTH, LYMANTRIA MONACHA L. (LEP.,LYMANTRIIDAE) IN THE SWISS ALPS: FIVE YEARS' EXPERIMENTS WITH DISPARLURE. Maksymov, K. (Swiss Feder.Inst. For.Res., 8903 Birmensdorf/Switzerland)

Results of experiments covering a period of 5 years and using 27 traps in 1974 and 51 traps in 1975-78 on 8 sites situated at an altitude of 1100 to 1500 m a.s.l. are presented. During this period the following amount of males were captured: 813 in 1974, 1524 in 1975, 1474 in 1976, 1217 in 1977 and 685 in 1978. From the gathered data it is concluded that even the very low population density during the time of latency shows variations from one site to the other, as well as fluctuations.

9S-4,28 Forest insect conditions in Korea.

Im, M. S.

9S-4,29 Insect problems in pine and hardwood plantations in the southern United States.

Hertel, G. D.

9S-4,30 Germany improving monitor systems for forest insect pest with special reference to the integrated control in the forests of the Germany Federal Republic.

Bogenschutz, H.

9R-1,1

DISTRIBUTION AND ABUNDANCY OF OAK-TREE DEFOLIATOR SPECIES IN DIFFERENT CLIMATIC ZONES OF KOSOVO / YUGOSLAVIA/.

Dr. Djordjije Djorović, Zavod za šumarstvo-Peć, B. Kidriča, 126. Yugoslavia.

In the Kosovo region/SAP Kosovo/, Srbija, the oak-tree/ Quercus sp./ is spread out in three climate zones: submediterranean, mild-continental and continental.

The structural properties of defoliator species of most important groups / Tortricidae, Geometridae,Noctuidae, Lymantridae, Lasiocampidae/ and other families / Plutellidae, Pyralididae, Phycitidae, Saturnidae, Lycenidae/, have been investigated in these forests, in which the characteristic, preferable and occasional sorts were included.

The specified sorts have had various population dynamics. Their quantitative structure varies depending on time and space factor. Beside the abundance and distribution, some other structural properties such as frequency, constancy, domain and way of nutrition, as well as diversity in biocenosis, have also been controled.

The abundance and distribution are the consequence of several parameters, the climate and floric element being the primary ones, as well as others such as nature reducents/ parasites and diseases/.

Submediterranean region in comparison with the continental, is scarse in individuals of preferent species, but richer in characteristic ones. In the continental parts there are more individuals of eurotype species then those of stenotype.

During the period of examination, three types of distribution have been found: uniform, group-type and sporadic.

9R-1,2

GENETIC ANALYSIS OF FOREST INSECT POPULATION STRUCTURE.

Stock, M. W., Dept. Forest Resources, Univ. Idaho, Moscow, Idaho 83843, USA

Electrophoretic techniques and statistical analysis of isozyme data are revealing details of forest insect population structure not previously discernible. Population differentiation of mountain pine beetles (Dendroctonus ponderosae Hopkins) has been shown to be associated with host/habitat types in localized areas. Population structure of western spruce budworm (Choristoneura occidentalis Freeman), as revealed by genetic comparisons, is increasing our understanding of patterns of budworm outbreak spread. Current research in this area is outlined and summarized.

9R-1,3

GEOGRAPHIC VARIATION OF NUMBER OF LARVAL MOULTS OF THE GYPSY MOTH IN JAPAN.

NAGASAWA, S. (Fac. Agr., Shimane Univ., Matsue,690 Japan)

An exhaustive investigation on the geographic variation and genetics in the gypsy moth, Lymantria dispar (L.), was made by Goldschmidt just half a century ago. As one of the most important problems, he conducted a comprehensive study of the geographic variation of number of larval moults using materials not only of Japan, but also of Korea, China, Germany, Spain and other European countries, and stated conclusively that the larvae of this moth may have four or five moults in both sexes and typically the five types may be found in the pure races. This problem was also investigated by Fernald and Leonard using north American materials. Based on the results of rearing experiments for twenty years using materials collected from more than fifty localities in Japan, the present speaker wishes to add some informations on this subject to senior's reports.

9R-1,4 BREEDING OF THE LOCAL RACES OF THE GYPSY MOTH AND A COMPARISON OF THEIR SUSCEPTIBILITIES TO A CPV AND A NPV.

Katagiri, K. and Iwata, Z. (For. For. Prod. Res. Inst., Ibaraki 305, Japan)

Egg hatch can be controlled by temperature treatment of eggs: Storage of eggs at a low temperature accelarates or depresses egg hatch.

Egg masses were collected from various localities of Japan and these broods have been inbred repeatedly for several generations to differenciate the races. They were found to be different in susceptibility to the virus diseases (a nuclear polyhedrosis and a cytoplasmic polyhedrosis). The hybrids between these broods were also studied. In inter-race crosses, some sex abnormalities were observed: A female of a Kyushu race, if crossed to a male of a Tohoku race, produces in the F_1 abnormal intersex offspring and likewise, some other crossings produce the sex abnormalities.

9R-2,5 ATTRACTION FOR JAPANESE PINE SAWYER *MONOCHAMUS ALTERNATUS* (COLEOPTERA : CERAMBYCIDAE)

Ikeda, T., Yamane, A., Enda, N. and Oda, K. (For. & For. Prods. Res. Inst., Ibaraki, 305 Japan)

Attraction mechanism of the chemical origins in the attractive, nematode-infected and freshly felled pine trees for *M. alternatus* causing the severe mortality of Japanese pine trees was investigated. From the trees felled, eleven pine specific monoterpene hydrocarbons (α-pinene, β-pinene, β-phellandrene, β-myrcene and camphene as the majors) and ethanol were identified as volatile components. The artificial bait dispensed with these commercially available chemicals showed strong attractiveness for *M. alternatus* in field bioassays. Ethanol which itself did not show any attractiveness strongly worked as the synergist to the monoterpenes. These chemicals were also detected from the nematode-infected pine tree under the laboratory conditions. Their quantities vaporized significantly increased after the cease of oleoresin exudation. The timing and the period of their developments matched well with those of *M. alternatus* attraction observed in the field. Trunk injections into living pine trees with simple chemicals like acetone or ethanol also showed the strong attractiveness for *M. alternatus*.

9R-2,6 AMPLIFICATION OF CHEMICALLY BASED HOST RESISTANCE: A NEW CONCEPT FOR LARCH SAWFLY CONTROL. Wagner M.R. and Benjamin, D.M. (School of Forestry, Northern Arizona Univ. Box 4092,Flagstaff, AZ. U.S.A.).

Larch sawfly, *Pristiphora erichsonii* (Hartig), larvae prefer tufted needles while rejecting single needles of their host, *Larix laricina* (DuRoi) K.Koch. Host-origin resin acids present in the single needles are responsible for the preferential feeding behavior. These compounds have growth retardant and antifeedant properties. Topical application of these materials amplifies natural host resistance and results in dispersal of larval colonies and feeding reduction under field conditions.

9R-2,7

PREFERENTIAL FEEDING OF THE PINE CATERPILLAR (DENDROLIMUS SPECTABILIS) ON THE OLD NEEDLES OF JAPANESE BLACK PINE (PINUS THUNBERGII) AND ITS ADAPTIVE SIGNIFICANCE.

Togashi, K. and Takahashi, F. (Ishikawa For. Expt. Sta., Ishikawa, 920-21 Japan)

Seasonal changes were observed in the preferential feeding of the 1st and last instar of the pine caterpillar on needles of the different age classes of Japanese black pine, which was investigated from May to October in the laboratory. The 1st instar larvae preferred the current-year (A0) needles, while the last instar larvae preferred the previous-year (A1) needles. The productive value of a needle of age t is defined as the contribution of a needle of age t to the future growth of the tree. The productive value is analogous to the reproductive value defined by Fisher (1930). The calculation of the results of the defoliation tests carried out by Furuno (1968) shows that the productive value of an A0 needles is greater than that of an A1 or A2 needle. The 1st instar larvae preferred A0 needles, but its consumption was very small. The last instar larvae fed voraciously but preferred A1 needles. Thus, the larval feeding preference reduces the deleterious influence of the feeding on the growth of the tree, as far as the larval density on a tree is at a low level. A1 needles preferred by the last instar larvae show a large ratio of (value to larva)/(productive value of needle). The seasonal trend of this ratio in A0 needles is consistent with that of the preference for A0 needles of the last instar larvae. Therefore, the feeding behavior of the last instar larvae is analogous to the preferential feeding of a 'prudent' predator on the prey with the largest ratio of (value to predator)/(reproductive value of prey) (MacArthur, 1960).

9R-2,8

HOST INFLUENCES ON MOUNTAIN PINE BEETLE BIOLOGY AND DYNAMICS IN LODGEPOLE PINE.

Amman, G. D. (Intermountain For. and Range Expt. Sta., U.S. Forest Serv., Ogden, Utah 84401, U.S.A.)

The mountain pine beetle, Dendroctonus ponderosae Hopkins, is the most destructive insect infesting lodgepole pine, Pinus contorta var. latifolia Engelmann, in North America. The beetle often kills over a million trees per year on a single National Forest. Beetle dynamics are closely tied to those of its host. Characteristics associated with beetle populations in trees of small diameter and thin phloem are low attack and gallery densities, slow brood development, low brood survival, small brood adults and a sex ratio heavily in favor of females. The opposite occurs in trees of large diameter and thick phloem. Infestation cycles are related to the proportions of large and small diameter trees in the stands.

9R-3,9

EGG PARASITOIDS PARASITING GYPSY MOTH (PORHETRIA DISPAR) IN KOREA.

Lee, Hai-Poong (Dept. of Agrobio., Seoul, 100 Korea)

Egg parasitoids, Ooencyrtus kuwanai and Anastatus japonicus, parasiting gypsy moth, Porthetria dispar (L.) collected from various parts of Korea were investigated during fall and winter in 1977 and 1978.

From 89.3% to 98.7% of the collected egg masses of Gypsy moth were parasited by the two parasitoids. Total percent of parasitization of egg masses by two parasitoid species are varied from 17.0 ± 1.9% to 11.7 ± 1.4% depending on the collection sites.

Fall generation of the egg parasitoids on egg masses were the major part of the total parasitization with 12.6 ± 3.1 per egg mass being the highest. The highest perasitization by Ooencyrtus Kuwanai were 93.8% of the total parasitization in fall generation and by Anastatus japonicus were 85.5% (highest) in spring generation with slight differences according to the sites.

The highest total parasitization by O. Kuwanai throughout whole year, were 70.8%, but varied according to the sites. The number of emergence of O. Kuwanai during fall season had peaks on every three weeks.

9R-3,10 THE ROLE OF POLISTES JADWIGAE IN NATURAL CONTROL OF GYPSY MOTH POPULATION.

Furuta,K.(Hokkaido Branch, For,& For. Prod. Res. Inst., Sapporo,061-01 Japan)

Severe outbreaks of gypsy moth in forests have often been observed in Hokkaido but quite rare in Kinki region,and the survivorship curves of the sparse populations in these two regions are different in shapes. This suggests that some other factors must be responsible for the natural control in Kinki, though the predation by birds is the main natural control agent if gypsy moth in Hokkaido (Furuta, 1976). In the forests in Kinki,where the larvae of gypsy moth were released on deciduous trees, functional and aggregative numerical responses of Polistes jadwigae to the prey density were observed and the larvae suffered a density-dependent mortality. The wasp isn't seen in Hokkaido and no other mortality factor plays the part as the wasp does in Kinki. The wasp,therefore,seems to make the gypsy moth populations more stable in Kinki region than in Hokkaido.

9R-3,11 A NEMATODE-TRAPPING FUNGUS AS A NATURAL ENEMY OF A PINE WILT NEMATODE.

Tatsumi,S.,Yoneda,K.,Katsumata,J.,Saiki,H. and Yamanaka K. (Environ. Sci.,Univ. Tsukuba) and Tsubaki,K. (Inst. Biol.,Univ. Tsukuba Ibaraki,305 Japan)

Japanese pine forests sufferred severe damage from pine wilt nematode, Bursaphelenchus lignicolus and its vector, Monochamus alternatus for recent ten years. There are no means of protecting pine trees from them except extermination of M. alternatus by pesticide. Recently, we isolated a nematode-trapping fungus from sap of sound red pine. This fungus was identified as Arthrobotrys sp. and showed effective predation of B. lignicolus. It would be a new species because of its high selectivity of trapping nematode;it trapped only one species, B. lignicolus and did not affect Diprogaster sp., Meloidogyne incognita and other nematodes usually found in soil. Its trapping organ was adhesive tip of lateral hypha. This fungus must lure and paralyze the nematodes, so they were captured. The trapped nematode died in a very short period within 30 minutes and then, were consumed and leaving only cuticles filled with the assimilative hyphae. These results suggests its potentiality as a natural enemy of B. lignicolus.

9R-3,12 TRICHOGRAMMA SP. (Hym. Trichogrammatidae), AN EGG PARASITOID OF IVELA AURIPES (Lep. Lymantriidae) IN HOKKAIDO, JAPAN, AND EVIDENCE OF A HOST COUNTERDEFENSE MECHANISM.

Schaefer, P. W. (Beneficial Insect Res. Lab., Newark, DE 19713 USA).

Ivela auripes, highly stenophagous on Cornus controversa (Cornaceae), is univoltine and overwinters in eggs which are laid in single-layer, geometrical shaped masses (ave. 54.6 per mass) on the trunk of host trees. Analysis of egg mortality showed 30.5% egg parasitism by a perfectly synchronized Trichogramma sp. (apparently new) which is nearly uniparental (2% males). Over 92% of egg masses contained this parasitoid with 3.9 progeny/host egg. Intra-mass distribution of parasitized eggs indicated 81% were on the perimeter of the mass. Normally ca. 54% of eggs were positioned on the perimeter but this varied with the number of egg rows (3-8). Eggs positioned in the interior of the mass showed low parasitism which was attributed to a gray dust material which the female moth placed on the surface of the egg mass during oviposition. The gray dust was acquired by the female prior to oviposition and from an external source. Dissections of female moths showed sac-like invaginations with large openings laterad of the gonopore. These 'dust sacs' were used to transport the dry dust until egg deposition. Observations of females, on host tree surfaces, occasionally revealed a curious side-to-side motion thought to be a 'rasping' process during which the gray material was scraped off the tree surface. The precise origin of the material is unclear. Genitalia examination showed morphological adaptations to accomplish this 'rasping behavior' and dust storage. The dust appeared to be an important barrier to Trichogramma oviposition in non-perimeter eggs.

9P,1 THE INFLUENCE OF INDUSTRIAL CONTAMINATIONS ON THE SOIL MESOFAUNA IN THE PINE FORESTS.

Khotko, E. (Dept. Zool.,Parasitol. Acad. Sci. BSSR, Minsk-GSP, USSR)

The analysis of the soil samples from natural pine forests and those contaminated with industrial wastes in the southern and northern Byelorussia has allowed the following conclusions to be made: only particular groups of the soil invertebrates exhibit changes in their quantity; the differences in the quantity depend on the time of the pollution action; the subdominant and recedent species are mainly affected rather than the dominant ones; the number of the Coleoptera species decreases by 12%; the zoomass amounts to 90% of that in the natural biocenoses, in the pine forests with a poorly developed grass cover it is by 32 to 43% lower; the aggregation index for many of the groups rises in the contaminated biocenoses.

9P,2 NATURAL ENEMIES OF GYPSY MOTH (LYMANTRIA DISPAR) IN JAPAN AND KOREA, ESPECIALLY NEW AND POTENTIALLY USEFUL SPECIES.

Schaefer, P. W. (Beneficial Insect Res. Lab., USDA, Newark, DE 19713 USA)

The USDA, Asian Parasite Laboratory in Sapporo, Japan, conducted exploration for natural enemies of gypsy moth (1975-79). Currently records include 41 parasites of L. dispar (in Japan unless indicated) including the following (total species and new records or species): Tachinidae 11 (Actia jocularis, Blepharipa schineri, Exorista larvarum, Pales pavida, Parasetigena n. sp. (Korea)); Braconidae 7 (Apanteles melanoscelus, Apanteles schaeferi, Apanteles lymantriae); Chalcididae 1; Encyrtidae 1; Eupelmidae 2; Eulophidae 2 (Elachertus charondas); Ichneumonidae 12 (Hyposoter vierecki, Melalophacharops sp., Phobocampe sp. not disparis); Scelionidae 1; Torymidae 1; Trichogrammatidae 1; and Nematoda, Mermithidae 2 (Hexamermis n. spp.). Presently 15 insect species are confirmed (including lab. confirmation only *) predators of gypsy moth. New records include predators on eggs, Anthrenus museorum, Anthrenus verbasci, Attagenus sp., Dermestes sp. (Dermestidae) and Ptinus japonica (Ptinidae); predators on larvae, *Rhyncoris leucospilus sibiricus (Reduviidae) *Arma custos, Picromerus fuscoannulatus (Pentatomidae) and Xylodrepa sexcarinata (Silphidae). Diseases include virus (CPV and NPV) and the fungus, Entomophthora aulicae. Those organisms considered the most successful natural enemies possess high (Hexamermis spp. Apanteles liparidis, Exorista japonica, Brachymeria lasus, Dinorhynchus dybowskyi, Entomophthora aulicae and the viruses) or moderate (Blepharipa spp., Parasetigena spp., Apanteles spp. other than liparidis, Rogas lymantriae, Xylodrepa sexcarinata, Calosoma maximowiczi) biological control potential.

However, the single most significant mortality factor in Hokkaido was mid-winter predation on eggs by mixed species flocks of overwintering birds. Predation of 34.5% over a wide area, or frequently over 90% in favorable sites (well sheltered areas) was recorded.

9P,3 GYPSY MOTH-HOST INTERACTIONS: EFFECTS OF DEFOLIATION UPON FOLIAGE CONSTITUENCY AND INSECT DYNAMICS.

Wallner, W.E., Valentine, H.T., and Wargo, P.M. (U.S. Dep. Agric., For. Serv., Hamden, Conn. 06514 USA).

Artificial defoliation of gray birch and black oak trees for 1, 2, and 3 years resulted in increased mortality, extended developmental time, and reduced pupal weights of 3 different geographic source populations reared on trees in the field. Foliar nutrients (8 elements and 18 amino acids) analyses of defoliated trees were conducted concurrently with insect rearing. The interactions between current year foliar constituents and gypsy moth development rates, pupal weights, and fecundity, and the effects of prior year defoliation on current year foliar constituents are discussed.

9P,4 I.R. PHOTOGRAPHY FOR EVALUATION OF SMALL PLOT TREE DEFOLIATION IN VERMONT.

Parker, B.L., Teillon, H.B., and Ogden, S.

Near infrared photographs were taken from ground level of sugar maple trees immediately prespray and 8 weeks postspray. Developed slides were projected on a back screen and defoliated leaf surfaces measured with a dot planimeter. Efficacy of Carbaryl, Imidan, and Bt as protectants against maple leaf-cutter populations was based on changes of defoliated leaf surface over time. Results based on IR were compared to actual insect counts taken prespray and 1,3,5, and 8 weeks postspray. Data were comparable and the use of IR photography is considered efficient and less costlier than taking individual leaf samples and insect counts for small plot efficacy testing in VT forests.

9P,5 POPULATION DISTRIBUTION OF PARACLEMENSIA ACERIFOLIELLA IN ACER SACCHARUM.

Parker, B.L., Teillon, H.B., and Aleong, J.(Agric. Expt. Sta., Univ. of VT., Burlington, VT., 05405)

Leaf samples were taken from sugar maple trees at select vertical and horizontal increments at each of the cardinal directions of the crown. No significant differences in numbers of mines, cuts, or cases of Paraclemensia acerifoliella were observed on leaf samples taken from the 4 quadrants (N,S,E,W). This insect prefers to lay its eggs near the base of the crown and in close to the bole of the tree. There were significantly more mines/leaf on samples taken 0.61 and 1.22 m from the bole than at 2.43 m and outward to the edge of the foliage. The highest number of cases/leaf was found 1.22 m from the bole. One and 2 months after termination of the leaf-mining stage the population was not evenly distributed throughout the tree. The case-bearers and highest degree of leaf damage were both more prevalent in a zone located from the bole outward to a distance of 3.04 m. The data presented illustrate the importance of consistency in sample selection when assessing numbers of this pest.

9P,6 SEASONAL FLUCTUATION AND SPATIAL PATTERN OF THE ADULT POPULATION OF THE JAPANESE PINE SAWYER, MONOCHAMUS ALTERNATUS HOPE, IN THE YOUNG PINE FOREST.

SHIBATA, E. (Nara For. Expt. Sta., Takatori, Nara, 635-01 Japan)

Adult of the Japanese pine sawyer, Monochamus alternatus Hope, is the primary vector of a nematode which causes the pine wilting disease. This study intends to determine the seasonal fluctuation and the spatial pattern of the adult population in the young pine forest. In the census, after shaken down from a tree on sheets of cloth spread on the ground around the tree, adults were counted and released again on the same tree after marked with the lacquer paint on their pronotum and/or elytra for identification of individual adults. The total number of adults caught by this procedure was 560 in 1078 and 330 in 1979. At the peak of the population (in the middle of June) the number of adults estimated by JOLLY-SEBER's method was 987.1 ± 651.1 in 1978 and 331.7 ± 154.0 in 1979. Adults tended to be distributed clumpedly on trees in this forest.

9P,7

SPATIAL PATTERN OF THE POPULATION AND INFESTATION OF THE PINE NEEDLE GALL MIDGE, *THECODIPLOSIS JAPONENSIS UCHIDA ET INOUYE* (DIP.; CECIDOMYIIDAE), IN A PINE STAND. Sone,K. and Takeda,H. (Fac. Agr., Kyoto Univ., Kyoto, 606 Japan)

The distribution pattern of the pine needle gall midge population was studied in a study site of 7.5 x 7.5 m^2 in area in a Japanese black pine, *P. thunbergii*, stand during the period from Apr. 1978 to Aug. 1979. The distribution of emerging adult females, dropped larvae, and overwintering larvae per unit size were all highly aggregated. The counts of egg clusters and galls per tree or per shoot also showed high aggregation indicating the aggregative pattern of infestation of this species in a stand. It was suggested that this aggregative pattern is due to concentrated oviposition resulted from the contagious spatial pattern of adult emergence in a stand, the inverse density-dependent mortality in hatched larvae, and the difference in the survival rate of hatched larvae among different crown levels. The dispersal and mortality of overwintering larvae seemed to have no significant effect on the changes in the spatial pattern of infestation of this species.

9P,8

Biology and mechanism of injury of Japanese cedar bark midge. Yoshida,N., Sanui,T. and Taketani,A. (Kyushu Branch For. & For. Products Inst. Kumamoto, 860 JAPAN)

The Japanese cedar midge(*Resseliella odai* (Inouye)) causes damage to the Japanese cedar (*Cryptomeria japonica* D.Don) which is one of the most economically important trees in Japan. This midge distributes in the southern three quarters of Kyushu. One or two generations usually occur in a year. Eggs are laid under the broken epiderms and the first larva crawls onto the surface of the inner bark. Digestive fluid for the feeding kills the phloem cells of the inner bark and makes a fleck. When the fleck reaches the cambium or xylem, the xylem tissues die and a stain appears in the wood. If the inner bark is thicker than the depth of the fleck, the stain of xylem does not occur.

9P,10

LIFE HISTORY OF *NESODIPRION JAPONICA* MARLATT (HYM. DIPRIONIDAE) IN NORTHERN HONSHU, JAPAN. Sato, H. (Iwate Pre. For. Expt. Sta., Takizawa, Iwate, 020-01 Japan)

Investigations on the life-history of *Nesodiprion japonica* MARLATT were carried out in Iwate-ken, Japan, from 1966 to 1972. The hibernated prepupae pupated within their cocoons in spring and the greater number of the adults emerged from the end of May to the beginning of July. Each female deposited 50 to 80 eggs, usually one egg per needle. The egg stage lasted 11 to 14 days and the larval stage about 40 days. The fully grown larvae spun their cocoons on the twigs and the adults emerged about 14 days after pupation. The egg stage of the second generation was 8 to 12 days and the larval stage 25 to 30 days. The mature larvae entered the soil litter to hibernate in their cocoons. However, some of them pupated immediately and the adults emerged after 14 days. The larvae produced by these adults completed their development and spun their cocoons in the soil litter.

As the results, this sawfly has two or three generations per year in northern Honshu, Japan.

9P,11 REARING OF THE SUGI BARK BORER, SEMANOTUS JAPONICUS LACORDAIRE ON ARTIFICIAL MEDIUM.

Yamada E. (Shimane Pref. For. Exp. Sta., Shinji,Shimane,699-04 Japan)

Among major forest tree species, Cryptomeria japonica is by far the most important because of its rapid growth and good wood quality. The sugi bark borer is very destructive to Cryptomeria, causing a damage called "Hachikami" which reduces the commercial value of the timber. Although "Hachikami" is regarded as one of the most destructive insect damages as far as the forestry management is concerned, populations of the borer in many plantations are usually not high. The scarcity of its number as an experimental material has caused the bottle-neck to the development of research on the borer. In order to develop a suitable mass rearing medium of the borer, thirty four different kinds of artificial diet were tested. Dried powders of sapwood, bark, main twig, current twig and needle of Cryptomeria were used as a main component with dried yeast, sucrose, sorbic acid, sodium benzoate and agar. The larvae successfully developed into adults on four kinds of diets in which bark powder(5-10% in weight) and dried yeast(4% in weight) were contained.

9P,12 AN ANALYSIS OF THE TREND OF THE PINE WEEVIL POPULATION ATTRACTED TO PINE BAIT LOGS.

Yoshikawa, K. (Fac. Agric., Kyoto Univ., Kyoto, 606 JAPAN)

In three Japanese red pine forests (two of them were protected by insecticide spray), adults of pine bark weevil, *Shirahoshizo* spp. (including three species), were trapped with pine bait logs for nine weeks. Based on capture-and-recapture data, some population parameters were estimated by the Jolly-Seber method.

Initial size of the attracted population seemed to be determined not by the general condition of the site but by the amount of the attractants offered from the bait logs. Although the sites were apart 1-3 km from each other, every site had almost similar pattern of the seasonal changes in the attracted population size. Such pattern could not be explained by any single environmental factor. Adult weevils continued to be attracted for a considerably long period with almost constant frequencies. Their habit of oviposition with frequent migration will make it possible to compensate their insufficient ability to overcome the tree resistance by dispersing eggs to many trees.

9P,13 THE ROLE OF BIOTIC FACTORS IN THE REGULATION OF THE BARK BEETLE POPULATION NUMBER.

Yanovsky V.M., Kiselev V.V. (V.N.Sukachev Inst. of Forest and Wood of the Sib. Branch of the USSR Acad. of Sci., Krasnoyarsk, USSR)

According to the analysis of the bark beetle population number dynamics, the intrapopulational interaction (competition, interference) and entomophagous insects, predators in the main, have proved to be of the greatest importance. The trajectory of the bark beetle survival rate changes under the influence of these factors has been stated to be characterised by the S-shaped curve. Threshold values of the intensity of the intra- and interspecies regulatory mechanism influence have been detected, these values changing the character of the xylophagous insect population number regulation qualitatively. It means that at certain indices of the bark beetle population density or of the predator effectiveness the predators may either be excluded from the system of regulatory mechanisms and even contribute to the increase in the bark beetle population number or become determinative and control the level of the bark beetle population density rigidly. The dependence of the biotic factor pressure on the station ecological conditions has been established.

9P,14 XYLOSANDRUS GERMANUS (BLANDFORD) (COLEOPTERA: SCOLYTIDAE): AN AMBROSIA BEETLE PEST OF YOUNG HARDWOOD PLANTATIONS IN THE UNITED STATES.

Weber, B. C. (Forestry Sciences Laboratory, SIU, Carbondale, IL 62901, USA)

Xylosandrus germanus (Blandf.), a native of Japan, was first reported in the United States in 1932. It now occurs across most of the eastern U.S. and has been reported from 22 genera of host plants. X. germanus is a serious pest in black walnut (Juglans nigra L.) and tulip tree (Liriodendron tulipifera L.) plantations aged from 1 to 7 years. A canker disease, caused by Fusarium solani (Mart.) Appel & Wr., is associated with most of the attacks. Symptoms include top dieback, stem and basal sprouting, cankers, and beetle pinholes. Up to one-third of the trees have been attacked in one year. Impact of X. germanus includes death of trees, loss of growth, and increased time spent in management of plantations.

9P,15 ENHANCED CONTROL OF HYLOBIUS ABIETIS L. WITH DECAMETRINE - PYRETHROIDE.

Schmutzenhofer, H. (Forestry Research Inst., A-1131 Vienna, Austria)

Laboratory and field tests were realized last year with DECIS EC-2,5, Decamethrin-Pyrethroide in Austria. An emulsion of 0,1 % gave good results in the prevention of Hylobius abietis damage to recently planted or potted pinaceous species. The product was efficient as a repellent to Hylobius abietis on Norway Spruce and Douglas Fir. Insect mortality was low. An emulsion of DECIS EC-2,5, 0,05% gave insufficient protection.

9P,16 Recent Trend of Forest Entomology in The People's Republic of China

Tsai Pang-Hwa (Institute of Zoology,Academia Sinica)

Investigating the insect depredations of the forest in China, the author was forcibly impressed that the forest insect problem is an important factor for the successful management of the forests. It was realized that large amount of investigations has been done with special efforts on bionomic studies of various species of forest insects. All of these investigations, together with the works of The Academy of Forestry Research and Provincial Institutions of Forestry showed that there are about 500 species in China. A synoptic forest entomology of China will appear after some time.

For the practice of integrated control of some important forest insects, the following points may be summarized as the essential measure to success: 1. Insect species identification and survey on their distribution and outbreak centers, 2. epidemiological studies on their bionomics,and the method of pest forcasting, 3. studies on forestrial managemant or forest plantation through mixed stands, 4. biological control as the principle means of insect population suppression and, 5. to carry out rational application of chemical insecticides on urgent situation.

Some important forest insects of China will be disscussed also in the paper.

9P,17 FOREST INSECT PROBLEMS IN TASMANIA, AUSTRALIA. Madden, J.L. (Fac. of Agric. Science, Univ. of Tasmania, Hobart, Tasmania, Australia).

Forestry contributes significantly to the Tasmanian economy employing 8 percent of the workforce and in 1976 the state produced 17 and 75 percent of Australian sawnwood and pulpwood respectively. Currently the value of woodchip export to Japan alone is of the order of $U.S.77 million.

Insect pest problems occur in *Eucalyptus, Nothofagus* and exotic *Pinus* spp. stands and the ecology of chrysomelid, geometrid and curculionid defoliators and attack of trees by platypodids and woodwasps will be described.

Management practices and natural events contributing to outbreaks and the impact of clear felling on the invertebrate fauna of both litter and trees will be discussed.

Section 10.

Stored Product Entomology and Structural Insects.

10S-1,1

The process of domestication of Tribolium brevicornis (Le Conte) (Coleoptera, Tenebrionidae). Sokoloff, A. Cal-State College, San Bernardino, California

A natural population of Tribolium brevicornis has been found associated with the carpenter bee Xylocopa tabaniformes orpifex (Anthophoridae) in decaying logs of Alnus rhombifolia near San Bernardino. This population, to be referred to as SB and its F_1 descendants were compared and contrasted with two long established laboratory strains to be referred to as Idaho (I) and Riverside (R). As expected, the SB feral sample showed considerable variation in body size, the largest beetle weighing four times more than the smallest beetles.--Beetles from the I and R strains were much heavier than the SB population and more uniform in size. The natural population differed significantly from the laboratory strains in such attributes as fecundity, cannibalism and dispersing ability. There were similarities in developmental rate from egg to adult. None of the three strains showed any tendency to fly under laboratory conditions, although beetles of all three strains have been observed to extend their membranous wings when they are lying on their backs.--The biological attributes which enable this species to become adapted to man-made habitats will be discussed.

10S-1,2

LIFE HISTORY PARAMETERS OF A WILD STORED PRODUCTS BEETLE, ZOPHOBAS RUGIPES (TENEBRIONIDAE)

Tschinkel, W.R.(Dept. Biol. Sci., Florida State Univ., Tallahassee, FL. 32306, USA)

The tenebrionid beetle, Zophobas rugipes, breeds in bat guano under crowded conditions. Crowding inhibits larvae from pupating, so that they must seek isolation to pupate. The age at which larvae seek isolation affects several population growth parameters--- age at first reproduction, fecundity and longevity. The age of a larva's mother also affects larval growth rate and adult fecundity. The effects of five major factors (larval density, larval age at pupation, age of mother, adult density) were tested in a fully factorial experiment on four dependent measures (larval growth rate, larval dispersal behavior, adult fecundity, longevity). All factors have important effects, especially age-of-mother, larval and adult density. These results are discussed in light of the colonization and exploitation of a stored=product-like resource, bat guano deposits. Differences among several populations, including one maintained in the lab for 15 years, are discussed in the context of domestication to stored-products.

10S-1,3

REPRODUCTIVE BIOLOGY OF THREE COLEOPTERA BRUCHIDAE DAMAGING PULSES

Huignard, J., Biemont, J.C., Jarry, M., Pierre, D. (Institut de Biocénotique Expérimentale des Agrosystèmes, Av. Monge, Parc Grandmont, 37200 Tours (France)

Three Bruchidae species (Acanthoscelides obtectus - Zabrotes subfasciatus - Callosobruchus maculatus) are important pests of pulses. The larvae develop inside the seeds and make them non consumable. Reproduction can take place both in the field and in storage. The biology of Bruchidae in nature is rather ignored but it has been observed that females stay long on mature pods before they oviposit. A. obtectus perforates the pericarp of the Phaseolus pods and oviposits inside. C. maculatus (active or non active forms) stick eggs on the surface of Vigna pods. Z. subfasciatus needs Phaseolus with dehiscent pods as it oviposites only on seeds. Ovipositional behaviour in storage which has been studied in depth is more simple. The female's reproduction is regulated by external factors (presence of pods or seeds and mating) and the adaptative significance of this regulation is studied. Knowledge of the natural cycle the Bruchidae is essential for pre-harvest prevention of pulse infestation. It is the most efficient method of control. Only populations of A. obtectus originating from equatorial areas (South Colombia) or tropical areas (Mexico) has been studied experimentally and the synchronisation between the reproductive cycles of host plant and insect is understood. In absence of ripe pods, the insects undergo an adult diapause.

10S-1,4 PROCESS OF DOMESTICATION VS. THE CONCEPT OF r- AND K-SELECTION.

Koichi Fujii and Masakazu Shimada (Inst. Biol. Sci., Univ. of Tsukuba, Ibaraki, 305, Japan)

Applying r- and K-selection theory as operational concepts in the process of domestication, we conducted model experiments in the laboratory(30°C, 70%R.H.). We reared two strains,jC and taC$_2$, of Callosobruchus chinensis(Coleoptera:Bruchidae) under artificial density-dependent(K-selection) and density-independent(r-selection) mortality, and investigated changes in ecological characteristics of both strains. jC had been raised for 30 yrs. in the laboratory before the experiments and taC$_2$ was introduced from field into the laboratory just before the experiments.

By comparing data from population counts at each generation and reproduction curves at generations 9 and 13 with those at the beginning, in K-selected cultures, increases of K (from 100 to 150 in 9th and to 170 in 15th generation) and fecundity per female (from 40 to 60) were seen in taC$_2$, but there were no such changes in jC (K was still about 200 and fecundity was 60 to 70). The rise of K-level in taC$_2$ was mainly due to the increase of total fecundity at high density. In r-selected cultures, we observed prominent increase of total fecundity but sharp decrease of hatchability at high density, and consequent decline of reproduction curves in taC$_2$.

From the results, we confirmed (i)field population of C. chinensis has wide genetic variation, (ii)artificial r- and K-selection could change easily some ecological characteristics of the insect, e.g., the increase of fecundity occured at relatively early stage of selection but improved hatchability at high density was not observed so far, and (iii) jC was higher in both r and K than taC$_2$. Based on these results, we attempt to discuss the process of domestication in stored product insects.

10S-1,5 LIFE HISTORY STRATEGY OF STORED-PRODUCT INSECTS. Yoshida, T., Tsuda, Y. and Kaneda, M.

(Facul. Agric., Okayama Univ., Okayama 700 Japan)

Life history strategy of stored-product insect pests is considered with reference to control measures. Figure 1 shows the classification of the life history strategy for stored-product insects based on reproductive and developmental strategy relationships.

Tribolium pattern of strategy having a relatively short developmental period and a long oviposition period is termed V-strategy. V-strategists are selected to prolong adult longevity (oviposition period) and have a high reproductive value for a considerably long period. The V-strategy is considered as another way of pests to adapt to variable and/or unpredictable environments. The changes of innate capacity for increase and reproductive value as the oviposition period is extended and the shape of m_x-function changes are shown by simulations. Fitness of the strategy is discussed in reference to adult feeding, resistance to starvation, copulation frequency, age-distribution, dispersal behaviour and response to fluctuating environments.

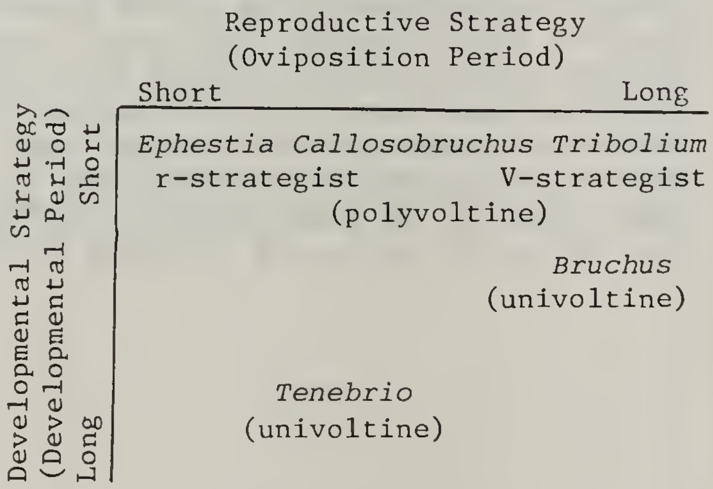

Fig. 1. Classification of the strategy

10S-2,6 THE DYNAMICS OF INTERACTION BETWEEN SITOPHILUS ZEAMAIS (MOTSCHULSKY) AND SITOTROGA CEREALELLA (OLIVIER) UNDER VARYING ECOLOGICAL CONDITIONS IN KENYA.

De Lima, C.P.F., (National Agric. Labs., Box 14733, Nairobi, Kenya)

Sitophilus zeamais and Sitotroga cerealella are major insect pests of maize in traditional stores in Kenya. Sitophilus zeamais infests the ripening crop and often completes one generation before harvest. Pre-harvest infestation by Sitotroga cerealella is usually small. Populations of both species occur together in most places but Sitotroga cerealella is dominant under the cool conditions of the Kenya highlands while Sitophilus zeamais is more abundant at lower altitudes and at sea-level. Under field conditions these populations do not reach an equilibrium level and do not stabilize. The age/stage structure does not reach a stable state before the maize is destroyed, and generally, lack of suitable grain leads to the earlier elimination of Sitotroga cerealella.

10S-2,7

INFESTATION OF RICE WEEVILS IN RELATION TO THE CONDITION OF DESICCATION AND THE STYLE OF STORAGE OF RICE GRAIN AFTER THE HARVEST. Takahashi, F. and Mizuno, H.(Fac. Integ. Arts & Sci., Hiroshima Univ., Hiroshima, 730 Japan)

The condition of drying and the style of grain at storage after harvest affect the degree of damage by pest insects. The reproduction and development of rice weevils, *Sitophilus zeamais* and *S. oryzae*, were compared from their life tables at 30°C, 70%RH under the different drying conditions of rice grain(natural drying by rack hunging or artificial drying by heated air) and at the different stepps of grain processing(unhulled, hulled, or polished). The longevity of adult weevils was the shortest on unhulled rice and the longest on polished rice. The reproductive power during adult life span was the smallest on unhulled rice and the largest on hulled rice. The period of preimaginal development was the longest on polished rice and the shortest on hulled rice. These results indicate that the unhulled grain is the most desirable style of storage. Mechanical heating made a split on rice husk which provides an oviposition site for weevils. Polished rice is a better style than hulled rice at the short period of storage within 10 weeks.

10S-2,9

SELECTED PROBLEMS ON COMPETITION AMONG POPULATION OF GRANARY BEETLES /SITOPHILUS GRANARIUS L.,ORYZAEPHILUS SURINAMENSIS L. AND RHIZOPERTHA DOMINICA F./ WITH SIMULATION MODEL APPROACHES . Ciesielska Zofia, /Institute of Zoology, High Pedagog. School, 31-054 Kraków, Poland.

The paper covers studies of the effect of interspecific interactions on the course of egg laying and on the population size at early stages of its growth. Furthermore the study deals with problems of influence of environmental factors on effect of interspecific relationship between confined populations in particular on their coexistance, domination and elimination. As there are differences in the course of interactions when a system is composed of two primary pest species as compared with systems consisted of a primary and a secondary pest. The degree of grain exploitation which includes both consumption and damage in systems of two competing species has been investigated and the amount of food used for production of 1 g biomass has been calculated. The simulation models approaches have been elaborated.

10S-2,10 STORED PRODUCT INSECTS AND THEIR SYMBIOSIS WITH MICROORGANISMS!

Jurzitza, G. (Botanisches Institut, Lehrstuhl 1, Universität D-7500 Karlsruhe, German Federal Republic)

Many pests of stored products live in an endosymbiosis with pro- or eucaryotic microorganisms. After a brief survey of the distribution and anatomy of the symbioses and of the transfer of the microorganisms to the offspring the microbiological and physiological work about the endosymbiosis of Lasioderma serricorne (Anobiidae) with a yeastlike fungus is reviewed. The significance of the endosymbiont is the supply of essential substances (vitamins, amino acids) and, in many cases, recycling of nitrogen. These functions of the endosymbionts seem to be of fundamental importance for wood eating ancestors of stored product eating insects but, as can be seen by many species without symbiosis, it cannot be regarded as essential in the occupation of the ecological niche "stored product".

10S-2,11 CHEMICAL FACTORS INVOLVED IN POPULATION ECOLOGY OF BEAN WEEVILS.

Honda,H., Sakai,A., Tanaka,K., Gokhale,V.G. and Yamamoto,I. (Dept. Agr. Chem., Tokyo Univ. of Agr., Setagaya, Tokyo, 156 Japan)

Many facets of life stages of bean weevils are regulated by chemical factors. Males of *Callosobruchus chinensis* are attracted to females by a pheromone released from the latter. Once attracted, the males expose the genital organ by stimulation of lipid from the females and copulate.

The oviposition of *Callosobruchus maculatus* and *C. chinensis* is stimulated by chemical components in the seed coat of kidney bean, *Phaseolus vulgaris*, cowpea, *Vigna sinensis* and azuki bean, *Vigna angularis*. *C. maculatus* is solely guided by the stimulant, whereas, for *C. chinensis* the physical stimuli such as size and smooth is more important. The oviposition and hatching do occur on the kidney bean, but the larvae are killed inside the bean by a proteinaceous component.

The females of two *Callosobruchus* deposit the eggs uniformly among the host beans under low population densities. Under high densities, the weevils deposit 15 or more eggs on one bean, but only a few eggs can hatch and grow in the bean. This strategy developed by the weevils to reduce the competition among the larvae and to maximally utilize the host beans, is regulated by lipid chemicals released from the weevils at the time of ovipositing and creeping on the host beans. The lipid is a mixture of fatty acids, triglycerides and hydrocarbons.

10S-3,12 LABORATORY STUDIES ON THE ROLE OF AN EGG PREDATOR *BLATTISOCIUS TARSALIS* (ACARINA: ASCIDAE) IN THE NATURAL CONTROL OF *EPHESTIA CAUTELLA* (LEP.: PHYCITINAE) IN WAREHOUSES.

Haines, C.P. (Trop. Stored Prod. Centre (Trop. Prod. Inst.), Slough, Berks., U.K.)

Effective control of *Ephestia cautella* by *Blattisocius tarsalis* has occasionally been observed in warehouses. It has been postulated that this control is negated by fumigation under sheets, because of differential effects on the moth and its predator, and removal of alternative prey. The biology of *B. tarsalis* was studied at 27°C and 73% r.h. With *E. cautella* eggs, development took 5.9 days with 7% mortality; with *Tribolium castaneum* eggs, it took 7.4 days with 48% mortality; and with a choice of eggs, the mites very rarely preyed on *T. castaneum*. Consumption of *E. cautella* eggs was as follows: nymphs - 3.8 eggs (total), ovipositing females - 2.4 eggs/day, non-ovipositing females - 1.5 eggs/day, and males - 0.8 eggs/day. The sex-ratio (female:male) was 2.5:1. Adult longevity averaged 55 days (max. 153 days), and the oviposition period lasted about 20 days. Females laid up to 6 eggs/day at peak oviposition. The potential rate of increase of *B. tarsalis* on *E. cautella* eggs was very high, far exceeding that of its prey. An experiment with laboratory populations showed that control of the moth by this mite is more effective in the presence of a secondary prey source (*T. castaneum*). These data confirm previous postulates and suggest that generation synchrony of *E. cautella* induced by fumigation reduces predator-effectiveness. Modification of control regimes might allow greater natural control by the mite and reduce the increasing pest status of the moth.

10S-3,13 Ecological notes on mites infesting stored products in Taiwan.

Tseng, Y.H. (Taiwan Branch Office, Bureau of Commodity Inspect. & Quaran. Mini. Econ. Affairs. R. O. C.)

In 1970 to 1979 inclusive, samples of stored products from different parts of Taiwan were examined for mites and their infestation. As much as 100% of husky rice, 69% of white rice, 95% of Indian corn, 87% of peanut and 71% of bean samples were found infested, and as many as 49 species (including some predacious ones) of mites were discovered. Cereals stored randomly on the ground in heaps were more liable to the infestation than those contained in bag. Mites associated with cereals in plastic bags propagated more rapidly than those in flax bags. The population density of the mites was highest in June to September and lowest in January to March. The most destructive species of mites were Tyrophagus putrescentiae and Suidasia medanensis popilations of which reached the peak in July to September and December to March, respectively. Most probably the former species prefer higher, while the latter species prefers lower temperature and relative humidity.

10S-3,14 SEMIO-CHEMICAL INTERACTION AMONG ACARID MITES.

Kuwahara, Y.(Inst. Applied Biochem., Univ. Tsukuba, Ibaraki-ken, 305 Japan)

Behavioral observation of the mold mites, Tyrophagus putrescentiae, indicated the presence of the alarm pheromone. Active principles of the alarm pheromone were isolated as a mixture of neryl formate as a major component and citral as a minor. The activity of citral was one-hundredth of neryl formate. Using natural and synthetic monoterpenoids, the structure-activity relationship was studied. Presence of carbon-carbon double bond between C_2 and C_3 with (Z)-geometry was essencial for the development of the activity. In order to study the species-specificity of the alarm pheromone, four species of related acarid mites, Aleuroglyphus ovatus, Carpoglyphus lactis, Lardoglyphus konoi and Dermatophagoides farinae, were employed. From these four species, citral was isolated as the sole active principle against mold mites. Within four species, at least two species, L. konoi and C. lactis were demonstrated to use citral as their alarm pheromone. The latero-abdominal gland(or oil gland) of all species was identified as the exocrine gland of the alarm pheromone.

Through bioassay it was noted that L. konoi contained another pheromone which functioned to attract not only their own species but also three other species(T. putrescentiae, C. lactis and A. ovatus). This active principle which was named as the aggregation pheromone of these mites was isolated. The structure elucidation of the compound is now in progress.

10S-3,15 THE ECOLOGICAL ROLES OF THE MITE ALARM PHEROMONE CITRAL

Okamoto,M.,Matsumoto,K.and Wada,Y. (Dept.Parasit.Tokyo Women's Med.Col.,Tokyo 162)

The antifungal effect on Aspergillus fumigatus by gaseous Citral which grain mites excreted had been reported (Matsumoto et al 1979). Except Citral and Neryl formate 6 volatile substances of the mite gave no inhibitory effect on growth of fungi. The antifungal effect of Neryl formate was much less than Citral. The antifungal property of the mite extract was regarded to be almost due to Citral.Citral excreted by the mite was supposed to inhibit the growth of many species of fungi in the mite habitat.

The escaping of grain mites from the culture medium is often observed. This phenomenon may be also related to Citral.

10S-3,16 TYROPHAGUS PUTRESCENTIAE AND FUNGI: EFFECTS OF TOXIN-PRODUCING STRAINS. Rodriguez, J.G., Potts, M.F., and Patterson, C.G.(Dept. Ent., Univ. Kentucky, Lexington, Kentucky 40546)

A number of species of *Aspergillus*, *Penicillium* and *Fusarium* fungi were cultured in appropriate media and axenically challenged with the acarid mite, *Tyrophagus putrescentiae*. The fungi represented proven toxin-producing strains as well as non-toxin-producing strains of the same species. The parameters measured were egg production, egg viability, survival, longevity, growth and development.

10R-1,1 ON THE OCCURRENCE OF "ACTIVE" AND "NORMAL" FORMS OF *CALLOSOBRUCHUS MACULATUS* IN TANZANIA. Mphuru, A.

10R-1,2 STATUS OF MAIZE WEEVIL RESISTANCE TO INSECTICIDES IN TAIWAN. Wang, S. C. and T. Y. Ku
(Pestic. Toxicol. Div., Plant Protection Center, Wufeng, Taichung, Taiwan 431, Republic of China).
The toxicity of six insecticides — Malathion, Diazinon, Dursban, Fenthion, Folithion and Ficam — has been tested against the maize weevil, *Sitophilus zeamais*, a major granary pest in Taiwan. The premixing of grains with insecticides gives an average 30-fold greater toxicity than topical applications. If treated by topical applications, Folithion, Ficam and Dursban appear to have a greater toxicity than Malathion; if treated by admixture methods, Malathion produces a higher toxicity than the other insecticides tested. The susceptible strain of maize weevil acquires resistance in ascending order to Malathion following consecutive treatments by selection pressure. The LD_{50} of its offspring to the other insecticides tested, however, has a fluctuating tendency under selection pressure. Results from an islandwide survey of the insect's resistance levels are described.

10R-1,3 EFFECT OF LOW OXYGEN ATMOSPHERES ON EGG HATCH OF TWO STORED GRAIN INSECTS.

Navarro, S. and Calderon, M. (Agric. Res. Org., Div. Stored Prod., Bet Dagan, Israel)

Tribolium castaneum and Ephestia cautella eggs were exposed to atmospheres containing O_2 concentrations of 2%-10% at 26° for 24-120 h. The hatch of T. castaneum and of E. cautella was fully inhibited at 4% and 8% O_2 concentrations, respectively. The effect of different relative humidities on T. castaneum eggs was not pronounced, while E. cautella eggs were more sensitive at lower relative humidities.

The response of different developmental stages of the tested species exposed to low O_2 concentrations is discussed. The high sensitivity of eggs to low O_2 atmospheres emphasize the feasibility of applying controlled atmospheres for insect control in grain storage produced by O_2 convertors.

10R-2,4 EFFECTS OF GAMMA IRRADIATION ON THE DEVELOPMENTAL STAGES OF THE BROAD BEAN WEEVIL (BRUCHIDIUS INCARNATUS BOH.).

Hafez, M., Osman, M.F. and Younes, M.W.F. (Dept. Ent., Fac. Sc., Cairo Univ., Giza, Egypt)

Bruchidius incarnatus Boh., is one of the most injurious pests of stored beans and leguminous seeds in Egypt. The variation in the radiosensitivity of this pest at different developmental stages was studied. The results obtained indicated that the effect of gamma irradiation was much more pronounced in early stages of development decreasing gradually from the egg to the larva to the pupa. Irradiation of egg at different stages of embryonic development, larval instars, prepupae and pupae at two different ages resulted in delayed and incomplete adult emergence. The effect of irradiating the immature stages of B. incarnatus Boh., was found to be passed over to the resulting adults which suffered from a gradual decrease in their longevity and female fecundity with increase in dosage. In the latter case an obvious increase in sterility was observed. Irradiation of newly emerged adults induced a high degree of sterility in both sexes and complete sterility was attained in males at a much higher dosage (12,000 rad) than in females (6000 rad).

10R-2,5 GENETICAL AND DEVELOPMENTAL STUDIES ON THE FIG MOTH (EPHESTIA CAUTELLA) REARED FOR SEVERAL GENERATIONS ON IRRADIATED DATES.

AL-Hakkak, Z.S., Ali, S.R., Ahmed, M.S.H., AL-Maliky, S.K. (Nuclear Research Centre, Tuwaitha, Baghdad, Iraq).

A research programme to thoroughly explore the effect of ionizing radiation for the control of stored-date insects was started at our centre in 1967. Parallel studies were also carried out on the detection of any changes that might occur in the chemical composition of irradiated dates. Consequently, a conclusion was made that dried date fruits, usually infested with different stages of stored-product insects, could be easily disinfested by using low doses of gamma radiation (Cobalt - 60 source). However, wholesomeness studies are needed in order to evaluate the safety of irradiated dates for consumption purposes. Therefore, in the present experiments the fig moth, Ephestia cautella, used as a test organism, was reared for 5 generations on a 100% diet of dates treated with 100 or 200 Krad of gamma radiation. Each generation was checked for development from egg to adult stage. Furthermore, female fecundity, mating frequency and the percentage of egg hatchability were also studied for all the 5 generations as indicators for genetical effects. Depending on these parameters, no statistically significant effects have been detected. These results suggest that disinfestation of dates with such doses of gamma radiation is a safe method in that it has no accumulative adverse effect on the quality of these fruits as a full diet for Ephestia cautella.

10R-2,6 EFFECT OF DIFFERENT LIGHT COLORS ON THE DEVELOPMENT OF KHPRA BEETLE (TROGODERMA GRANARIUM).

Mahmood, Imad A. and A. F. Al-Azawi, (Plant Protection Dept., Technical Institute of Agriculture, Foundation of Technical Institutes, Baghdad Iraq)

The development of khpra beetle was studied at 30°c and 70-75% RH inside 7"x7"x7" wooden boxes lined with glossy colored paper either white, black, red, yellow, green, blue or light blue for UV. A 15-watt light bulb of the same color was placed 4" above a 3" hole in the box top. Under UV light, in a light blue lined box, the average periods for larva, pupa, pre-oviposition, oviposition and the generation were 54.35, 7.28, 3.00, 2.50 and 74.21 days, respectively. UV color was significantly different from other colors at 5% level in the larva, pupa and the generation. Also, lavae has 9 instars under UV as compared to 5 under red and 6 under other colors. The lowest average of eggs laid was under UV with 16 eggs/ with 0 hatchings as compared to the highest of 45.50 eggs/ and 63.3% hatching under red.

10R-2,7 STORED GRAIN'S INSECTS ATTACK IN MEXICO BY MEANS OF RADIATIONS.

Ramírez, M. M. (Lab. Ent., Zool. Inst. Bi&oacute;l. UNAM., México, 70-153 México.)

Entomology deals with the use of atomic energy for pacific uses like that of food preservation. All procedures that man has used for grain preservation, have been very varied, being radiation the most recent one. Ionized radiation protects the grain from destructed caused by microorganisms and insects, with the adventage they don't lose nutritional value. It depends on the kind of insect to be eliminate and the results to be obtained from the administration of radiation doses. Grain preservation proces by means of Cobalt-60 radiations, electrons and laser ray suggest a more intensive use in our country for food preservation and also for solving nutritional problems in Mexico's socio-political landscape.

10R-3,8 EFFECT OF MOISTURE CONTENTS IN WHEAT AND AIR ON KHAPRA BEETLE (TROGODERMA GRANARIUM).

Al-Azawi, A. and Imad A. Mahmood (Plant Protection Dept., College of Agriculture, University of Baghdad, Abu Ghraib, Baghdad, Iraq)

The effect of 5, 7 and 12% moisture content in wheat seeds and 5, 7 and 12% RH, respectively on the biology of khapra beetle was studied under 30°C. After one day, mortality for 1st instar larvae was 53, 43 and 3% and at the end of the stage was 89, 72 and 29%. Larval periods were 165.33, 100 and 34.25 days and pupa were 8.66, 7 and 5.2 days. Male life span was 4, 5.66 and 7.33; and female life span was 5.33, 7 and 10.33 days. The average number of eggs/female were 2, 8.75 and 36.25 and percent hatchings were 0, 30 and 78. The generation periods were 179.33, 112.50 and 47.75. Seed damage was 0.6, 3.44 and 26.39%. Defferences among each group of data were significant at 5% level except for pupal periods and adult life spans.

10R-3,9

MODE OF INJURY TO COCOONS CAUSED BY LARVAE OF THREE DERMESTID BEETLES. Nakamura, S. and Nakamoto, N.* (Sericul. Exp. Sta., Yatabe, Ibaraki, 305 Japan) *(Silk Conditioning House, Yokohama)

Mode of injury to cocoons caused by larvae of three Dermestid beetles was studied.

Method: Larvae of (A) Black Carpet Beetle (*Attagenus piceus*), (B) Black Larder Beetle (*Dermestes ater*) and (C) Cabinet Beetle (*Anthrenus verbasci*) were divided into groups consisting of 7, 23 and 65 larvae respectively and placed in the covered glass containers of 34 cm in diameter and 66 cm in height filled with 650 cocoons per group. The tests were carried in a wooden house in the site of the Station for four weeks from July 24, 1979, at 30.7°C on an average. At the end of the tests insect feces were weighed and damages on cocoons were observed macroscopically. According to the certified testing method reeling was examined.

Results: Damages determined macroscopically revealed that perforated cocoons were found much in the (C) group while the (A) and (B) groups resulted in the same quite few, thus their damages were hardly determined compared with the control. From the reeling test it was found that results were poor in every item compared with the control, specially notable damages were seen in the (B) groups. It was characteristic that the (C) groups were found with a deep hole at a certain part while the (A) and (B) groups were found with damages on all over the surface of a cocoon. Damaged cocoons were studied under scanning electron microscope, which confirmed the above result.

	(A)			(B)			(C)			
Item	7	23	65	7	23	65	7	23	65	Control
Raw silk percentage (%)	41.37	39.46	37.62	40.22	38.43	37.17	42.50	42.42	38.79	44.80
Reelability percentage (%)	58	53	57	45	40	50	63	61	58	66
Brushing waste (g)	0.053	0.064	0.087	0.059	0.075	0.091	0.049	0.043	0.056	0.029

10R-3,10

Size and Structure of Coptotermes formosanus Shiraki Colonies in Hawaii. M. Tamashiro, J. R. Yates, P. Y. Lai, J. K. Fujii, N. Y. Su (Dept. of Ent., Univ. of Hawaii, Hawaii 96822, U.S.A.)

Mature field colonies of the Formosan subterranean termite Coptotermes formosanus Shiraki averaged 2 million individuals per colony. The largest colony contained over 10 million individuals. Periodic sampling indicated that the size of the colonies did not vary significantly from year to year. The ratio of workers to soldiers remained relatively stable. A few nymphs were found in the colonies throughout the year although swarming occurred in May or June and did not occur every year.

10R-3,11

A Technique for Screening Control Agents for the Subterranean Termite. N.Y. Su, and M. Tamashiro. (Dept. of Ent., Univ. of Hawaii, Hawaii 96822, U.S.A.) and M.I. Haverty (Forest Service, U.S.D.A. Pacific Southwest Forest and Range Experiment Station).

Active infestation of Formosan subterranean termites Coptotermes formosanus Shiraki are difficult to control because the termites are able to detect treated areas of the infestation and seal these areas off thus preventing the control agent from being spread to the rest of the colony. A laboratory technique was developed to study this defensive behavior to determine whether this behavior pattern could be by-passed. In addition, this technique was used to test the repellancy or attractiveness of pesticides and pathogenic microbes.

10P,1 Food Preference of Stored Product Insects to Processed Taro Products

Jang, E.and Mitchell, W. (Dept. of Ento. Univ. of Hawaii, Honolulu, HI.)

Adults and larvae of seven insects known to attack stored products were tested for food preference to various processed taro and sweet potato products along with a "traditional" whole wheat flour control. Adults of the flour beetles, Tribolium confusum and T. castaneum showed a distinct preference for the wheat flour controls. Larvae of T. confusum also chose the whole wheat flour over the processed taro products. The larvae of T. castaneum prefered the Chinese taro rice, but did not develop sucessfully in this medium. Adults of the Indian meal moth Plodia interpunctella prefered the sweet potato slices, taro slices and red raw taro noodles with equal frequency. Larvae of this species as well as adults and larvae of the cigarette beetle, Lasioderma serricorne did not seem to chose any one product but generally could be found in a majority of the test materials. Adults of the Merchant grain beetle, Oryzaephilus mercator prefered the contol flour. Both the grainary weevil, Sitophilus granarius and the rice weevil, S. oryzae adults preferred the red raw taro noodles. Larvae of these species were not tested. These results indicate that some of the insects prefer the taro products over the control flour and can become potential pests of these products. Tests on development of the immature stages on taro products indicate that certain species are successful. Further studies in this area should be considered in future production and storage of these products.

10P,2 EFFECT OF A LASER LIGHT ON SOME STORAGE PEST INSECTS.

Conconi J. Ramos Elorduy (Instituto de Biología, Universidad Nacional Autónoma de México, Apartado Postal 70-153, México 20, D. F., México).

Adults of insects that cause damage to stored foods, Tribolium confusum, Prostephanus truncatus, Oryzaephilus surinamensis and Sitophilus zeamais were exposed to the action of a laser light of an argon laser adjusted in a wavelenght of 4880 A° at different energy levels. The effects were computed: mortality, sterility reduction of longevity lack of movement, lethargy and anorexia. Modifications of behaviour, changes in the life cycle, changes of reproduction, Reduction of F_1 size and changes in melanization and Sclerotization in F_1.

10P,3 RADIOGRAPHIC STUDIES OF THE DEVELOPMENT OF CALLOSOBRUCHUS MACULATUS FAB. (COLEOPTERA, BRUCHIDAE) IN COWPEA,

Osuji, F.N.C. and Mills, R. B. (Dept. of Entomology, Kansas State Univ. Manhattan KS 66506, USA)

Cowpea seeds of four varieties namely PI 293446, PI 293531, IVU 37 and 'Commercial' infested with Callosobruchus maculatus Fab. were radiographed daily from oviposition to completion of adult emergence to study the development of the beetles inside cowpea seeds. Enlarged photographic prints made from the radiographs greatly facilitated interpretation. The radiographs were inaccurate in defining the early instars, but indications of larval tunnelling were obtained as early as the 5th and 6th days in some cases. Detailed information was obtained as to the structure and duration of the fully-grown larva, pre-pupa, pupa and pre-emerged adult. The fully grown larva was recognised on the radiographs by its strongly-curved body, and was observed from about the 18th day in PI 293531, 18-20th day in PI 293446, and 17th day in IVU 37 and 'Commercial'. The pre-pupa appeared as a pear-shaped individual; its duration was remarkably short, usually one day, rarely two, in all the varieties. The pupa was distinguished from the preceding stages by its prominent body form, with wing buds and well-developed appendages. The fully-formed adult remained in the seed for 3.2 days in PI 293531, 4.4 days in 293446, 1.7 days in IVU 37 and 1.5 days in 'Commercial'. The duration of development was not significantly affected, within each variety, by the number of individuals that developed in one seed. A maximum of six insects developed in one seed of 'Commercial', and four in each of the other varieties. Differences in the duration of development as well as patterns of adult emergence of C. maculatus in the four varieties of cowpea are discussed in relation to their possible varietal resistance/susceptibility traits.

10W-1,1

INITIATION OR PREVENTION OF DIAPAUSE IN LARVAE OF *PLODIA INTERPUNCTELLA* HB. UNDER CONTROLLED CONDITIONS. Abdel-Rahman,H. and Abdel-Kader,M.(Dept. Ent., Fac. Sci., Ain Shams Univ., Abbassia, Cairo, Egypt)

The influence of combined temperature and relative humidity, temperature and photoperiod, cycling temperatures, temperature prior to hatching, and chilling of eggs were tested. Temperature was the major factor governing the initiation or prevention of diapause. The relative humidity showed a minor influence. Continuous darkness or short photoperiods at 20°C were more inductive to diapause than long photoperiod. The latter at a higher temperature of 30°C completely averted diapause. A higher incidence of diapause could be induced at cycling temperatures than at a constant temperature equal to their mean. Incubation of eggs at 30°C and rearing of larvae at 20°C caused a rather high percentage of diapause; but temperatures from 15-25°C during incubation and 30°C during larval development discouraged the occurrance of diapause. Chilling of eggs tended to decrease diapause incidence. the effect, however, was considerably modified by larval breeding temperatures. In almost all cases, conditions which induced more diapause tended to maintain it longer.

10W-1,2

Some observations on the biology of *Zabrotes subfasciatus* (Boh.)Bruchidae: Coleoptera). H.R.Pajni and Anita Jabbal (Dept.Zool.,Panjab Univ.,Chandigarh,India).

Zabrotes subfasciatus (Boh.)is a multi-brooded pest of stored *Phaseolus lunatus* (*Rajmash*)but also attacks the seeds of *Vigna sinensis* (*Rongi*) and *Glycine max* (*Soybeans*). The eggs are laid on the surface of the seeds whereas the immature stages breed within the seed. The attacked seeds are badly damaged, being no longer fit for human consumption. The bruchids do not feed in the adult stage. They are poor fliers but run about fastly on the surface of the seeds. The adult bruchids exhibit the peculiar habits of feigning death, cleaning their body parts and occupying the empty seeds before their death. The copulation lasts for 14-32 minutes and the fertilized female lays on average of 52 eggs under the optimum conditions of 30°C and 70% R.H. Likewise, the shortest oviposition period of 3.3.days and highest rate of oviposition of 8.8 eggs per day have been recorded under 35°C and 50% R.H. A female lays many eggs on the surface of a single seed but a maximum of 21 larvae develop into adults in a single seed. The seeds of *P.lunatus* are given preference over other seeds for egg laying. The developmental period is also the shortest on these seeds. The natural mortality in the immature stages and adults is negligible as compared to that of the eggs. The eggs are also attacked by a parasite, *Uscana mukerjii* Mani.

10W-1,3

FIBRE-REACTIVE ORGANOPHOSPHORUS ESTERS AS DURABLE INSECTPROOFING AGENTS FOR WOOL.
Jones, F.W. (CSIRO Div. of Text. Ind., Geelong, Vic., Australia).

Because of their poor durability, organophosphorus compounds are generally unsuitable as insectproofing agents for wool. To overcome this shortcoming a number of organophosphorus esters containing reactive groups which are capable of combining with functional groups present in wool were synthesized. To retain their insecticidal activity these phosphorus esters must be released in an active form during the digestion of the wool by the target insect. This was achieved by incorporating a labile bond between the insecticidal and fibre-reactive portions of the molecule. As insectproofing agents are traditionally applied to wool during dyeing, this bond must remain substantially intact during application in a boiling acidic dyebath. A carboxylic ester bond was found to possess the necessary balance of hydrolytic stability and enzymic cleavability and was used to couple the fibre-reactive radical to the organophosphorus ester.

Some phosphorus esters also undergo significant hydrolysis during application from a dyebath. The most hydrolytically stable phosphorus esters studied were those based on 4-alkylthiophenol.

The influence of the chemical structure of these compounds on the application efficiency to wool and their insecticidal activity against *Tinea metonella*, *Tineola bisselliella* and *Anthrenus flavipes* is reported.

10W-1,4 STORED-PRODUCT INSECTS COMMUNITY IN A BARLEY MILL.

Imura, O. (National Food Research Institute, Ibaraki 305, Japan)

Stored-product insects in a barley mill were surveyed once or twice a month during March 1975- June 1976. In each survey samples of 200g of barley dust were collected from 15 sampling places in the mill and the insects were extracted from these samples using modified Tullgren funnels. In these surveys 24 species of stored-product insects were extracted and the species most abundant was *T. confusum*. *S. oryzae* was 2nd in number, followed by *E. kühniella* and *R. dominica*. The insect fauna of the barley mill was compared to those of flour mills, feed factory, and farm granaries using Morisita's index of similarity. The fauna was very similar to those of flour mills and little common to those of farm granaries. Then the seasonal change of species diversity in the mill was investigated. The species diversity(Brillouin's index) behaved in an erratic manner. The cause of the irregular change of species diversity in the mill will be discussed.

10W-1,5 RECENT ASPECTS OF STORED PRODUCT ENTOMOLOGY IN NEW ZEALAND

Somerfield, K.G. (Plant Health Diagnostic Station, M.A.F., Lincoln, New Zealand.)

Stored product insect problems in New Zealand since 1970, and interceptions at quarantine of potentially important species, are reviewed.

Dermestes maculatus De Geer has recently been a pest in North Island poultryhouses, where mature larvae have damaged wooden structural materials. *Alphitobius diaperinus* Panzer also occurs frequently in poultryhouses. *Hofmannophila pseudospretella* (Stainton) larvae were reported on television in November 1979 to be attacking woollen carpets, many less than 5 years old. In the following month 180 complaints were reported, of which 70% were confirmed as due to *H. pseudospretella*. During the mid-1970's some problems were experienced with insects contaminating dried milk products after long periods of storage.

Stored products insects recently reported from New Zealand include: *Reesa vespulae* (Milliron), *Tineola infimella* Herrich-Schafer, and *Sphaericus gibboides* Boieldieu. Quarantine interceptions of economic significance to New Zealand include: *Bruchus pisorum* (L.), *Trogoderma granarium* Everts, *T. variabile* Ballion and *Anthrenus flavipes* LeConte.

10W-1,6 ANCIENT DESCRIPTIONS ON STORED INSECT PESTS FOUND IN THE JAPANESE AND CHINESE CLASSIC LITERATURES.

Yasue,Y. (Ent.Sect.Inst.Agri.Biol.Sci.Okayama Univ.,Kurashiki,710 Japan)

China: The first record of rice weevils (*Sitophilus* sp.) was described apparently as the name of "Ku Shih" in the Chinese oldest dictionary "Erh Ya" which is so-called published about the third Century B.C. Lately,a Chinese famous scholar, Kuo,Po' (276-324 A.D.) annotated this dictionary. He wrote well the word of "Ku Shih" as explained that "Recently,these small black borer weevils injured severely, rice grains."

Japan : In HEIAN Era, a Japanese famous scholar, Minamoto-no-Shitago published a dictionary "Wamyo-Ruiju-Sho"(about 931-937 A.D.). On the chapter 240,insect section in his book,he also cited the name of "Ku Shih"and he has given the Japanese insect name "Yona-Mushi" of which means an insect pest of stored rice grains.

In the late of TOKUGAWA Era,a famous naturalist,Kurimoto-Tanshu issued a coloured textbook of a thousand insects, "Sen-chu-Fu" (1811). He described rice weevils in detail by using a microscope in his book. Additionally,he pointed and drawn the Japanese important Azuki bean weevils, (*Callosobruchus chinensis* L.).

10W-2,1 AN INSECT BIOASSAY TO EVALUATE CEREALS AS FEEDS. *Loschiavo*, S.R. (Can. Agric., Res. Stn. Winnipeg, Manitoba , Canada, R3T 2M9).

An assay using the duration of the larval period of the confused flour beetle, *Tribolium confusum* Jacquelin du Val as a criterion, was developed to evaluate cereal cultivars as feeds. Food was ball-milled and made into aggregates to ensure that insects could not discriminate between different fractions of the ground kernels. Significant differences in larval development time occurred among cultivars. The results of tests with chicks and larvae fed the same rations showed good correlation. In tests with barley lines and cultivars of different lysine content larval development was significantly faster on those containing the most lysine. The assay offers a rapid, reliable, and economical method for screening cereal lines in the early stages of a plant breeding program. It may be a useful alternative to the traditional method of using large animals to evaluate the quality of feed grains.

10W-2,2 STUDIES ON THE BIOLOGY OF *CALLOSOBRUCHUS SUBINNOTATUS* (PIC.) (COLEOPTERA, BRUCHIDAE), A STORE PEST OF VOANDZEIA SUBTERRANEA (L.) (THOUARS) IN NIGERIA. *Taylor*, T. Ajibola, I.A.R. & T., University of Ife, Moor Plantation, Ibadan, Nigeria.

Studies on the biology of *Callosobruchus subinnotatus* (Pic.), an important pest of *Voandzeia subterranea* (L.) (Thouars) showed that newly-emerged females began to oviposit within 24 hours of emergence and continued ovipositing at decreasing rates for 5 - 11 days. The oval eggs are cemented to the seed testa and females laid a mean number of 101 eggs ± 22.6 (range 67 - 129 eggs) and lived for 3 - 17 days. The total period of development from egg deposition to adult emergence when one egg developed per seed varied from 30 - 38 days, but when many eggs were developing in each seed the period of development may be as long as 61 days on *Voandzeia*, and up to 8 adults developed successfully in one seed. The numbers of individuals developing in one seed influenced the weight losses in seed and the size and weight of emerging adults. The bruchids developed successfully in true groundnuts (*Arachis hypogea*), emerging as adults after 46 days. Eggs deposited on cocoa beans, palm kernels and cowpea hatched, but the larvae did not complete their development on these stored products. The significance of these results is discussed in relation to cross-infestation possibilities in transit sheds and large commercial stores. An 'active' form similar in characteristics to the 'active' form of *C. maculatus* (F.) is identified and described from some old cultures with high population densities; the factors inducing active form production in the species is still imperfectly understood.

10W-2,3 IN-TRANSIT SHIPBOARD FUMIGATION OF GRAIN. Davis, R. (USDA-SEA/AR, Stored-Product Insects Res. & Dev. Lab., Savannah, GA 31403, U.S.A.)

The in-transit fumigation of grain on ships can be an effective and a safe procedure which will expedite the loading of grain at ocean terminal elevators. Guidelines as to the acceptability of ship types and construction, choice of fumigants and their effectiveness, safety monitoring, aeration procedures, and possible residues are discussed.

10W-2,4 RESISTANCE LEVELS IN IMMATURE STAGES OF A STRAIN OF TRIBOLIUM CASTANEUM, SELECTED FROM ADULTS WITH PHOSPHINE. Nakakita, H., (Nat. Food Res. Inst., Tsukuba, Japan) and Winks, R.G., (CSIRO, Div. of Ent., Canberra, 2601 Australia)

The response of immature stages of a Phosphine-resistant strain of *Tribolium cataneum*, which was selected from adults, was compared with those of a susceptible strain. Greatest resistance was observed in early- and mid-pupae which was greater than that of adults. These results may indicate the practical difficulties in controlling phosphine-resistant strains of this species in field populations. Although the relationship between respiratory inhibition and tolerance level of each strain was well correlated, there were no differences in terms of the contents of mitochondrial cytochromes and microsomal P-450 in tissues of each stage of both strains.

10W-2,5 VARIATIONS IN THE RESPONSE OF GRAINS TO FEEDING, OVIPOSITION, AND DEVELOPMENT OF THE RICE WEEVIL. Boles, Hobart P. (U.S. Grain Marketing Research Lab. USDA, AR, Manhattan, Kansas 66502)

Because of the increasing concern over chemical residues, the development of alternate control measures for stored grains has not only become a desirable objective but also a mandatory objective. One of the most intriguing of the suggested alternate methods, is the application of host-plant resistance to stored-grain insects. Complicating the use of resistant grains, is the fact that the growing plant has a much greater variety of potential defense mechanisms then threshed grain; however, researchers have found sufficient substantial differences in the response of insects to stored grain to suggest that those differences could be of enormous value. Studies are presented on different U.S. commercial varieties of wheats grown in different crop years, to indicate the possible effects of moisture, aging, hardness, protein levels, environmental growth conditions, and genetic background of these wheats on rice weevil oviposition and development.

10W-2,6 TAXONOMIC RESEARCH ON INSECTS ASSOCIATED WITH STORED PRODUCTS

D.G.H. Halstead. (Slough Laboratory, Ministry of Agriculture Fisheries & Food, U.K.)

The taxonomy of storage insects had received little attention prior to the second world war when the importance of conserving food stocks resulted in a considerable effort being put into stored products research in Britain. Classic contributions on the taxonomy of storage coleoptera and lepidoptera were published by the late Professor H.E. Hinton and his colleagues in the 1940's. These early studies were followed by many others in which the storage entomologist's "species" was often shown to be more than one species and the value of genitalia as a means of identifying members of difficult genera was fully demonstrated. A review of research carried out during the last 25 years highlights the importance of taxonomy in stored products research - the way in which poor knowledge may result in worthless records and place biological and other studies in vacuo. A lesson to be learnt is that voucher specimens should be kept and the fact that sound taxonomic determination is a prerequisite for effective communication should not be forgotten.

Section 11.

Medical and Veterinary Entomology.

11S-1,1 ACTIVITIES OF THE WHO SCIENTIFIC WORKING GROUP ON THE BIOLOGICAL CONTROL OF VECTORS. Pal, R. (Div. Vector Biology & Control, World Health Organization, Switzerland)

Under the auspieces of the UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases, WHO established a Scientific Working Group on Biological Control of Vectors in 1977. During the past three years research on the biological control of vectors has made rapid progress and has reached the stage at which the operational use of certain agents, in particular some entomopathogenic spore-forming bacteria, could take place in the near furure. Contacts have been established therefore with Industry and other UN agencies such as FAO, UNEF and UNIDO to ensure a smooth transfer of information from research to application for vector control in tropical countries. The BCV-SWG established a strategic plan of work right at the beginning and a prioroty list of biological control agents was prepared in 1979. Priority 1 has been given to further work on *Bacillus thuringiensis* serotype H-14, followed by other bacteria (*B. sphaericus*) a number of fungi, nematodes (Mermithids), predatory mosquitos (*Toxorhynchites*) and fish. It is intended to develop a network of Collaborating Institutions in tropical countries for the biological control of vectors. Specific data sheets summerizing all relevant information on a number of biological agents have been prepared for wide distribution and others are under preparation. The search for new biological control agents is continuing and special efforts are being made to study the safety of biological control agents for mammals and non-target species, the standardization of material and the preparation of specifications.

11S-1,2 THE USE OF POECILIID FISHES IN THE CONTROL OF MOSQUITOES IN ASIA AND THE PACIFIC.
Sasa, M. (National Institute for Environmental Studies, Tsukuba-Yatabe, Ibaraki 305, Japan)

Freshwater fishes of the family Poeciliidae includes some 140 species, mostly ovoviviparous, and all of them are native of tropical or subtropical zones of Americas. However, some of them have been introduced in Asia and the Pacific islands, and are acting as efficient natural enemies of pest mosquitoes. For example, Sasa et al. (1965) observed natural breeding of the guppy, *Poecilia reticulata*, in sewage pools in Bangkok, and found that it acted as an effective measure in the control of *Culex fatigans* when artificially introduced into the breeding places. In 1965, Sasa and Kurihara observed in Sri Lanka that introduction of the guppy into abandoned wells and coconut hust pits was effective in the control of filariasis vectors and could save expenses and labor for insecticide application. The guppy was found also naturally breeding in sewage ditches in several hotspring towns in the mainland of Japan. This fish species cannot stand temperature below 13°C, and Okinawa is the northern limit where it breeds under natural conditions, but it is highly tolerant to low dissolved oxygen contents of polluted waters. On the other hand, *Gambusia affinis* was found to be naturally breeding in sewage pools and ditches in and around the city of Tokyo. This fish species is also relatively tolerant to water pollution, and can survive through freezing temperature of mainland Japan. Effective control of pest mosquitoes have been achieved by artificial introduction and breeding of Gambusia from Tokyo to Tokushima City in Shikoku and several other areas in Kyushu, where the fish colonies were successfully established in sewage ditches, swamps and rice paddies, thus causing remarkable reductions in the mosquito populations. Several poeciliid fish species, including guppy and Gambusia, were shown by Nakagawa and associates as being highly effective in the control of mosquitoes in Hawaii under various environmental conditions.

11S-1,3 THE PRESENT STATUS OF BIOLOGICAL CONTROL OF MOSQUITOES IN CHINA. Lüh Pao-ling (Institute of Microbiology and Epidemiology, 11 Taiping Road, Beijing, CHINA)

Among the fishes, both indigenous and introduced species studied as predators for larval control, more attention has been paid to those of economic importance. Thus, fries of the common carp, *Cyprinus carpio*, have been liberated into ricefields, at the rate of 6000 to 7500 per hectare, for the control of *Anopheles sinensis* and *Culex tritaeniorhynchus* with considerable success. They will grow to several ounces at weight at the time when the rice is ready for harvest and can be marketed or transferred to fish ponds for further growth. Another indigenous fish, *Ctenopharyngodon idella*, has been suggested to be used in ditches or dams to clean the vegetations for larval control. The interest of *Gambusia affinis* and *Poecilia reticulata* has also been revived in recent years. The studies of other predators, such as *Toxorhynchites*, *Sphaerodema*, etc., are in progress. Many studies have been devoted to *Bacillus thuringiensis* var. *israelensis*. Both laboratory and field tests indicated that culicine larvae, such as *C. pipiens pallens* and *C. tritaeniorhynchus*, are highly susceptible to this microorganism and one bioinsecticide factory is planning to produce several tons for further use. Surveys of indigenous mermithids, entomopathogenic fungi and other biocontrol agents have also been emphasized.

11S-1,4 PATHOGENS OF BLACKFLY LARVAE IN GUATEMALA AND THEIR INFLUENCES ON NATURAL POPULATIONS OF THREE SPECIES OF ONCHOCERCIASIS VECTOR.

Takaoka, H. (Dept. Med. Zool., Kagoshima Univ., 890 Japan)

Investigations on pathogens and parasites in larval blackflies in and near the Guatemalan areas of endemic onchocerciasis were made from Aug. 1978 to Jan. 1980. Five distinct mermithids, 10 species of microsporidans, Coelomycidium sp. and two viruses were found. Natural infection levels of these pathogens varied considerably from each vector species. Simulium ochraceum did not harbour mermithids, whereas S. metallicum and S. callidum frequently did so. Microsporidiosis was rare in S. ochraceum, but common in the two others. Fungal infection was rarely found in S. ochraceum and S. metallicum. Infection of iridescent virus was observed in S. metallicum and S. callidum from two locations. In addition, the pathogen incidence was influenced by the type of stream (permanent or temporal) and the season.

11S-1,5 PROSPECTS FOR THE USE OF CULICINOMYCES FUNGI FOR BIOCONTROL OF MOSQUITOES.

Sweeney, A.W. Malaria Research Unit, RAAMC., Ingleburn, NSW 2174, Australia

Fungi of the genus Culicinomyces are aquatic Deuteromycetes - first discovered in 1972 in Sydney, Australia and in North Carolina, USA - which offer considerable promise as biological control agents of mosquito larvae. Ingested spores adhere to the foregut and hindgut regions of the digestive tract where they germinate and penetrate into the haemocoel which becomes filled with hyphae. After a few days the larvae die and a sporulating layer (which is infective to other larvae) is formed on the exterior cuticle. In the laboratory the Australian isolate has produced consistent mortalities in Anopheles, Culex and Aedes larvae with LC 50's in the order of 10^3 spores/ml. The spores can be stored at -70°C for at least six months without loss of infectivity and they can be formulated in aqueous suspension for field application. Preliminary field tests have yielded encouraging results. A recent trial conducted in a natural breeding site at Camden, New South Wales, resulted in a 95% reduction in Culex australicus larvae following application of 10^{10} spores/sq.m.

Important characteristics of Culicinomyces, relevant to its consideration as a biocontrol agent, include: its ability for mass production by industrial fermentation techniques; its potential for recycling after the initial application; its specificity for mosquitoes and related aquatic dipterous larvae within the Division Culicimorpha; and its apparent safety for other aquatic invertebrates and terrestrial animals.

11S-1,6 RECYCLING OF LAGENIDIUM GIGANTEUM COUCH AND OTHER MICROBIAL AGENTS IN RELATION TO MOSQUITO CONTROL IN RICE FIELDS AND OTHER CULTIVATED SYSTEMS IN CALIFORNIA, USA.

Washino, R. K. (Dept. of Ento., Univ. Calif., Davis, CA. 95616, USA).

The overwintering survival patterns of Lagenidium giganteum, Romanomermis culicivorax and other microbial agents have been studied in mosquito breeding sources in the agricultural areas of northern California. Successful establishment and subsequent recycling of the microbial agents are discussed in relation to crop management practice, water quality and temperature. L. giganteum appears to be a promising biological control agent against Culex tarsalis, but less so against aedine and anopheline species. Adverse effects on nontarget invertebrates seem to be minimal. The success against anophelines with R. culicivorax in ongoing rice field studies indicate that a large scale operation employing both the fungus and nematode will warrant serious consideration for use in controlling Culex tarsalis and Anopheles freeborni in California rice fields.

11S-1,7 SOME PRIORITIES RELATING TO THE BIOCONTROL OF DIPTERA OF MEDICAL AND VETERINARY IMPORTANCE

Laird, M.(Res. Unit Vector Pathol., Memorial Univ., St. John's, Newfoundland, Canada A1C 5S7)

"What is it?", "where is it found?" and "has it potential as a practical biocontrol agent?" are all questions pertinent to the future role of applied invertebrate pathology in integrated methodologies for vector control. The first of them has sometimes been wrongly answered with respect to, e.g., fungal pathogens, amongst which *Coelomomyces* has attracted much interest. Although largely confined to mosquitoes, this genus of the Blastocladiales has been mentioned as possibly present in Central American Simuliidae, while species have been described from Chironomidae, Phlebotomidae and Tabanidae. There are indeed representatives of *Coelomomyces* in chironomids of at least Czechoslovakia and Canada. However, much recent collecting by Japanese workers in Guatemala has failed to reveal any infections in any of the simuliids studied; while a species allegedly of this genus recorded from a South American phlebotomid has turned out to be an entomophthoralean fungus (with close relatives in the south of France and Algeria), and another described from tabanids in the USSR has been transferred to a fascinating and so-far monospecific genus of the Entomophthorales, *Tabanomyces*. Turning to the second question, the geographical and host list for *Coelomomyces* continues to grow. For example, several of them have now been recorded from various mosquitoes of Taiwan, including two genera from which these fungi were previously unknown. Finally, while it is of course essential to continue the search for additional candidate biocontrol agents, there are now two mermithid nematodes (*Romanomermis*) of mosquitoes, and the dipteran pathogen, *Bacillus thuringiensis* var. *israelensis*, suitable for commercialization and exploitation, and meriting priority attention to ensure their early emergence as the first practical biocontrol agents in medical and veterinary entomology.

11S-1,8 POPULATION REGULATION IN IMMATURE MOSQUITOES AND BIOCONTROL STRATEGIES

Service, M.W. (Dept.Med.Ent.,Liverpool School Trop.Med., Liverpool, UK).

The resurgence in many areas of malaria and the disillusionment with insecticides has refocussed attention on the possibilities of biological control of mosquitoes. Whereas there have been some outstanding successes of biocontrol of agricultural pests, there are few convincing examples of similar control of disease vectors. There are, however, underlying differences between the ecological strategies of plant pests and disease vectors which make biocontrol easier with the former. Mosquitoes are good examples of r-strategists, that is they have a high fecundity and reproductive rate, short generation time and are typically colonisers of temporary habitats, characteristics that make their populations resilient to many kinds of mortality.

Although there are long lists of mosquito parasites and predators, there is unfortunately extremely little quantitative ecological information on their natural enemies or how their populations are regulated. In the past there has too frequently been an emperical approach to biocontrol, but if biocontrol is to have a chance of succeeding alone or, more realistically, in combination with other control strategies, more reliable data on the population dynamics of the vectors must be obtained. A plea is therefore made for a better understanding of the mortalities acting on natural mosquito populations so that more appropriate biocontrol strategies can be formulated.

11S-1,9 STRATEGY FOR BIOLOGICAL CONTROL OF MOSQUITOES BASED ON POPULATION STUDIES

Mogi, M. (Dept. Med. Zool., Nagasaki Univ., Nagasaki 852, Japan)

Successful inclusion of biological agents into the integrated control system is attainable only through basic ecological studies. Mosquitoes which breed in open ground pools sufficiently stable to be inhabited by predators often suffer large mortality due to the complex of aquatic predators, threfore biological agents should be used in order to help this mortality. Introduction of hervivores destroying weeds obstructive to predators' activities, introduction of predators occupying different niches from those of native predators, and application of mass-produced parasites specific to mosquitoes meet this strategy. The reproduction rate of mosquitoes breeding in small-container habitats is controlled usually by overcrowding in larvae under the absence of effective predators, therefore intensification of overcrowding effects may be often more promising than introduction of imperfect natural enemies whose effects would be compensated by weakened intraspecific competition. A plan meeting this line is introduction of competitors including mosquitoes of different species or strains poor in vectorial capacity. Our ecological knowledge is yet very small considering a wide spectrum of mosquito breeding habitats. For instance we know little about dynamic interrelation within the biological community in small-container habitats. Also we have no detailed population studies on running-water breeders. Much more ecological studies are needed to find new candidate species for biological control and to establish the strategy appropriate for each case.

11S-2,10 THE TAXON AND THE SPECIES. Miles, S. (Ross Inst., L.S.H.&T.M., Keppel St, London WC1E 7HT, U.K.)

Fundamental to the understanding of an organism is the knowledge that one is dealing with a single species, ie. a group of individuals with the same mate recognition system. Evidence for the operation of different SMRS's come from evidence of assortative mating through the use of simple genetic markers such as inversions and electromorphs. A species then becomes defined in terms of these markers. These may not be the most convenient characters to use for identifying individuals, however, and, as well as for other reasons, the formal taxonomy is still necessary.

11S-2,11 TOWARDS A PHYLOGENY OF ANOPHELINE MOSQUITOES OF THE SUBGENUS *CELLIA*

Green, C. A. (Dept. Med. Ent., SAIMR, Box 1038, Johannesburg 2000, South Africa.)

A phylogeny for the subgenus *Cellia* is constructed from detailed homologies between the polytene-chromosome arrangements of representative species from both the Subsaharan, and Oriental zoogeographic regions. Despite the small sample of species from the approximate 180 species in the subgenus, detailed patterns of relationship are apparent which are not evident from morphological criteria. Furthermore these relationships indicate the present day barrier between the two regions, the deserts of the Middle East, has been highly transient in terms of the evolutionary history of the group; a transience that may have been an important feature in speciation events of the group. The phylogeny is constructed within the frame-work of Hennig's phylogenetic systematics, and has a hypothetical time direction. It is hoped that the scheme will provide a useful basis for any cytogenetic analysis of other species. As greater details are added to the tree its many hypothetic statements will be tested, and provide one of the most detailed intercontinental comparisons that we have.

11S-2,12 POPULATION GENETICS AND EVOLUTION OF NEOTROPICAL ANOPHELINE MOSQUITOES. Steiner, W.W.M. and Kitzmiller, J.B. (Dept, of Genetics and Development, Univ. of Illinois, Urbana, Il. and Florida Medical Entomology Lab., Vero Beach, Fl.)

We have examined the extent and types of genetic variation in the New World Nyssorhynchus mosquitoes of South America. Our studies show that extensive allozyme polymorphism is present and that heterozygosity levels show consistent, latitudinally-dependant clines. Examination of genetic differences at the species level, sibling-species level, and intraspecific (population) level reveals that diagnostic genetic characters exist where species can be clearly defined, but that sibling species genetic identities do not differ from intraspecific genetic identities. Several evolutionary models are presented to explain these results, and the implications for vector control are discussed.

11S-2,13 SPECIATION IN NORTHERN AEDES TREE HOLE MOSQUITOES. Munstermann, L. E.

(Dept. Biol., Univ. Notre Dame, Notre Dame IN 46556, USA)

Isozyme electrophoretic and cytogenetic comparisons were made within and between two groups, the Triseriatus Group (subgenus Protomacleaya) in North America and the Geniculatus Group (subgenus Finlaya) in Europe. The Aedes triseriatus Group consists of three sibling species: triseriatus, hendersoni, and brelandi. In Ae. triseriatus, differences between local populations were negligible, and populations from the north-south extremities of the range (27° to 47° N. Latitude) had G.D. of less than 0.12. Genetic differentiation across the range of Ae. hendersoni was low (G.D.=0.02-0.04). A comparison of triseriatus and hendersoni resulted in a G.D. of 0.28 to 0.42; sympatric collections yielded a distance of 0.35. Among the 18 loci, 4 were diagnostic and 5 more had alleles of sufficient frequency difference to identify the species of the population sampled. Interspecific crosses were viable. However, the TRIS females crossed to HEN males produced sterile intersex males. Aedes brelandi was very similar to Ae. hendersoni (G.D.=0.04-0.07); no sterility appeared in the hybrids. Aedes brelandi/triseriatus crosses produced the same pattern of sterility and chromosomal behavior as hendersoni x triseriatus.

Aedes geniculatus exhibited little enzyme variability in populations sampled from England and Italy (Sardinia). The G.D. between them was very low with one, or possibly two, enzyme loci distinguishing them on a frequency basis. When enzyme migration rates of geniculatus and triseriatus were compared, only 7 of the 21 enzymes assayed migrated at similar rates, indicating that the two species are not closely related.

Determination of chromosomal homologies among species is feasible by comparison of enzyme linkage maps. Linkage maps were produced for the Aedes triseriatus Group by interspecific crosses and subsequent mapping of 9 enzyme loci in the backcrosses. Map comparisons become possible with other subgenera, e.g. Stegomyia (aegypti) and Ochlerotatus (atropalpus-epactius; mariae-zammitii), that have been similarly crossed.

11S-2,14 CLASSIFICATION OF POPULATION DIVERSITY IN THE CULEX PIPIENS COMPLEX.

Barr, Allan Ralph

11S-2,15 HOW MANY KINDS OF MOSQUITOES ARE THERE ?

White, G.B. (Dept. Ent., London School of Hygiene & Tropical Medicine, WC1E 7HT, UK).

The medical importance of some mosquitoes as disease vectors became known towards the end of the 19th Century and gave a great incentive to the taxonomy of the Culicidae. Fewer than 200spp. had been named and described before Ross (1896, 1897) reported the malaria-carriers to be 'grey' or 'dapple-winged' mosquitoes. In the ensuing scramble to propose scientific names for mosquitoes from all parts of the world, much synonymy arose and is still with us. Yet the discovery of genuinely "new" mosquito taxa is unabated. Successive totals of recognized species have been 1400 listed by Edwards (1932), 2401 by Stone et al. (1959), 2960 by Knight & Stone (1977) and approximately 3,150 at present. The categories of variety and race are now obsolete and few geographical subspecies are name-worthy. More than two-thirds of the known mosquito species belong to the principal genera Aedes (990spp.), Anopheles (404spp.) or Culex (790spp.). There are three monotypic genera (Galindomyia, Maorigoeldia, Opifex) and the numbers of described species per genus are 2-10 for Aedeomyia, Bironella, Chagasia, Ficalbia, Limatus, Udaya and Zeugnomyia, 11-20 for Deinocerites, Hodgesia and Malaya, 21-30 for Haemagogus, Heizmannia, Mansonia, Orthopodomyia, Phonomyia and Sabethes, 31-50 for Armigeres, Culiseta, Eretmapodites, Mimomyia, Psorophora, Topomyia and Trichoprosopon, 55 Coquillettidia, 64 Toxorhynchites, 108 Wyeomyia, 110 Tripteroides and 184 Uranotaenia. While revisionary morphological studies continue to produce more additional taxa than are sunk, faunal surveys reveal about 10-20 new species per annum from the field. Genetical, cytotaxonomic and isozyme studies have revealed many cases of sibling species pairs or multiples. Thus the real number of biological species of Culicidae is more than the obvious morphological types, possibly in excess of 10,000spp. It is also clear that genetic polymorphism and non-genetic pleomorphism (e.g. larval hairiness variation) give many additional phenotypes which should be characterized and classified as mutants or forms of particular mosquito species.

11S-3,17

Attractants, repellents, and behavior-modifying chemicals associated with mosquitoes and tsetse flies.

Dame, D. A., and Weidhaas, D. E., AR, SEA, USDA, P. O. Box 14565, Gainesville, FL 32604, USA

The Insects Affecting Man and Animals Research Laboratory at Gainesville, Florida, includes as part of its program development of behavior-modifying chemicals. Several hundred compounds have been tested for repellent activity. None are significantly better against mosquitoes than deet but several show promise against other types of biting insects. New synthetic pyrethroids appear promising as protectants in clothing since they act rapidly enough to prevent biting and also kill attacking insects. Advances have been made in methodology for determining mosquito attractants in human emanations. Cooperative studies on tsetse flies with scientists in England have isolated and identified pheromones responsible for sex recognition and mating stimulation.

11S-3,18

OVERCROWDING FACTORS OF MOSQUITO LARVAE. Ikeshoji, T. (Dept. of Agr. Biol., Univ. of Tokyo, Tokyo 113) and Ichimoto, T. (Dept. of Agr. Chem., Osaka Pref. Univ., Osaka)

Life tables of mosquito larvae worked by others have shown a density-dependent mortality factor which was presumably food shortage in the field waters. Meanwhile, I have demonstrated a self-limiting chemical factor in a crowded population of Culex pipiens fatigans in the lab. This factor was identified as 7-methyloctadecane and 8-methylnonadecane.

In this presentation, genesis, metabolic fates in the breeding water and modus operandi against younger larvae of these hydrocarbons are discussed. Larvicidal activity of the synthetic hydrocarbons and their metabolites are also evaluated by modifying their chemical structures; in geometrical isomerism of an alkyl branch, change of the main chain-length, introduction of a double or triple bond and optical isomerism.

11S-3,19

POPULATION DYNAMICS OF MOSQUITOES. Seawright, J. and Weidhaas D. (Agr. Res., SEA/USDA, Gainesville, Florida USA 32604)

Control or management of pestiferous or disease-carrying mosquitoes will depend more and more on quantitation of the dynamics of populations (patterns of growth in practical problem areas). Key parameters controlling dynamics of several species of mosquitoes will be discussed in relation to the effectiveness of control technologies to be used against them. Variations and similarities in these key parameters between mosquito species will be highlighted particularly for *Anopheles albimanus* and *Culex p. quinquefasciatus*.

11S-3,20 SOME ASPECTS OF THE POPULATION DYNAMICS OF AEDES ALBOPICTUS.

Mori, A.(Dept. Med. Zool., Nagasaki Univ. School of Med., Nagasaki, 852 Japan) and
Wada, Yoshito(Dept. Med. Ent., Nat. Inst. Hlth., Tokyo, 141 Japan)

The larvae of Aedes albopictus breed in any kind of small artificial containers. By recording numbers of larvae in each instar, pupae and newly emerging adults every day in glass vials placed in the field, some population attributes were estimated. Under the condition of high larval density, the survival rate of larvae was low, and particularly first instar larvae mostly died without developing to the second instar, and the larval period was markedly long. Furthermore, the size of adults resulting from high larval density became small. As the females resulting from high larval density tended to take a longer time from emergence to blood feeding, their chance to die by the time of blood feeding, and also to emigrate from the breeding site, would be larger. These are the density dependent processes, which are often strengthened by the starvation, because the food supply is limited in such small containers. It is considered that the population density of Ae. albopictus is stabilized by such processes.

11S-3,21 MODELLING MOSQUITO SURVIVAL, AND ITS IMPLICATIONS FOR THE EPIDEMIOLOGY OF VECTOR-BORNE DISEASES.

A.N.Clements and G.D.PATERSON (Shell Research Limited, Sittingbourne, United Kingdom)

Reanalysis of published survival data for wild populations of mosquitoes has shown that in most cases the adult female mortality rate increases with age, and that in a high percentage of populations it accords with the Gompertz model, i.e. the logarithm of the mortality rate is directly proportional to age. All current models of malaria transmission assume the simple exponential model of mortality, i.e. that the vector's mortality rate is constant with age, and this can lead to substantial errors when wrongly applied. In the exponential model, all females have the same life expectancy whatever age they are, and this makes calculation of the vectorial capacity of the population very simple. When Gompertz mortality characteristics apply, older females have lower life expectancies than younger females, and calculation of vectorial capacity is not simple. A method for calculating the vectorial capacity of populations with Gompertz characteristics is presented.

11S-4,22 Evolutionary Relationships of Parasitic Arthropods and Mammals (Introduction).

K. C. Kim (Dept. Ent., Frost Ent. Mus., Penn State Univ., University Park, PA 16802 U. S. A.)

Coevolutionary relationships between permanent arthropod parasites and mammalian hosts are explored by bringing together all of the known evolutionary parameters. Coevolution is defined as the evolutionary interactions (reciprocal adaptations) between parasites (consumers) and hosts (suppliers). Diversity relationships and distributions with reference to geological history of hosts, habits, habitats, microhabitats of ectoparasites, host behavior and biology, and evolutionary strategies of ectoparasites will be considered.

11S-4,23 COEVOLUTION OF ANOPLURA AND MAMMALS.

Ludwig, H.W. (Zool. Inst., Heidelberg Univ., D-6900 Heidelberg, FRG)

Coevolution of host and parasite is the result of the parasite's host specificity. Anoplura, although considered to have a high degree of host specificity, show only a partial coevolution with their hosts. Only 29 out of 42 genera of Anoplura are confined to a single family of mammals, and only 10 out of 15 families to a single order. These facts indicate rather frequent changes of host associations at different times, on different taxonomic levels, and for different reasons. Positive and negative statements on coevolution are presented in detail for *Pedicinus* (exclusively parasitic on Cercopithecidae) and for those species of *Hoplopleura* and *Polyplax* parasitic on endemic and immigrant rodents of the Australian region. In some cases conclusions are possible about the phylogenetic age of anopluran taxa and about the time of invasion of a new host group.

11S-4,24 COEVOLUTION OF ECTOPARASITIC DIPTERA AND THEIR MAMMALIAN HOSTS.

Wenzel, R., Div. Ins., Field Mus. Nat. Hist., Chicago, Ill. 60605 USA

The obligate haematophagous dipterous ectoparasites of mammals are the Streblidae and Nycteribiidae (on bats) and some species of Hippoboscidae. Ancestral batflies were probably guano feeders which became intimately associated with bats and exploited them as the primary energy resource. Subsequent coevolution involved a wide range of behavioral, morphological and developmental adjustments (including pupipary and even endoparasitism) to the host substrate, behavior and ecology. This in turn led to host specificity and co-speciation between hosts and parasites. Sister species may be parapatric, allopatric or sympatric. Speciation events probably mostly fit the "vicariance biogeography model", but sympatry resulting from ecological speciation is not ruled out. Examples of taxonomic concordance between hosts and parasites are given. Although valuable in providing insights into phylogeny, this type of analysis must be approached with caution because of departures from co-speciation, including secondary invasions and radiations by new adaptive types that evolved through competition and nich partitioning. Old and New World faunae are compared. Differences between batflies and Hippoboscidae are pointed out. Areas for future investigation are suggested and limitations indicated.

11S-4,25 Co-Evolution of Fleas and Mammals. By Robert Traub University of Maryland School of Medicine at Baltimore. (Dept. of Microbiology, 660W. Redwood St. Balto. Md. 21201)

Data on the zoogeography, evolution and adaptations of fleas strongly suggest that these ectoparasites co-evolved with their particular major hosts. Primitive fleas occur on the primitive hosts, while the most highly evolved forms are found on the more youthful taxa of mammals. While fleas can shift and adapt to a new group of host that penetrates their area or habitat, or accompany their hosts to a distant region, they only rarely descend the evolutionary scale to infest a more primitive group of mammal. Unrelated fleas have often converged so greatly in chaetotaxic modifications that a mere glance at their spines, combs or bristles permits one to make valid deductions about the systematic position, vestiture or even the habits of the host. Thus, spiny mammals tend to have spiny fleas, and the spines of all kinds of shrew fleas look alike and differ from those of their kin on moles. Marsupials with coarse fur have fleas whose pronotal spines are modified accordingly, i.e. they are dagger-shaped, with the gaps tailored to fit the bristly hairs. Siphonaptera on mammals that fly or glide from tall trees, or otherwise pose extra hazards for fleas that become detached or fail to take hold when leaping onto the host, tend to have supernumerary combs or bristles, as in fleas with helmets or "crowns of thorns". Such species cling firmly to the hairs of the host and remain attached for hours at a time. In contrast, the fur fleas of abundant diurnal rodents move about actively in the pelage, feed rapidly, and then leave the host. There is an excellent coorelation between the level of chaetotaxic hyperdevelopment and the degree of risk imposed by the host. Some of the Siphonapteran modifications are complex and involve four "coordinated" evolutionary developments, including changes in the shape of the head as well as the position and type of spiniform bristles. Such specializations are absent in congeners which infest "ordinary" types of hosts, i.e. those that are not arboreal and nocturnal, etc.

11S-4,27 Prostigmatic mites as adjunct indicators of mammalian phylogeny.

Nutting, W.B.

11S-5,28 POPULATION DYNAMICS OF HOUSE DUST MITES IN JAPAN WITH SPECIAL REMARKS OF MOISTURE CONTENT AS A GROWTH FACTOR. Oshima, S. Inst. of Basic Medical Sciences, Univ. of Tsukuba. Niihari-Gun, Ibaraki-Ken 305, Japan.

The most limitative factor for the growth of the population of house dust mites is considered the moisture content in the house dust. Few quantitative studies about this subject, however, has been reported. To desiccate quantitatively the environment of house dust mites, we used the silica gel which was packed into 2.0 kg bag and placed in three houses of asthmatic patients. The amount of silica gel used varied from 64 kg to 188 kg under the Tatami floor matt, from 28 kg to 80 kg in the bedding closet, and/or from 30 kg to 128 kg under the mattress of bed. They were renewed monthly. The humidity of the environments was suppressed especially during July and August. The amount of moisture content taken off from environmental materials varied from 1.25 litre to 3.0 litre per day in maximum among the houses. The mite density dwelling in the house dust was examined by means of slide glass traps with a few drops of liquid paraffin. They were placed upon the floor for a week in every month. The number of traps varied from 8 to 15 according to houses including three control untreated houses. The number of mites captured in a trap attained to 30 in maximum, and they comprised 20 different species in total. A peak of population density of mites was observed in the control houses in July, nevertheless in the treatment houses this peak disappeared. This fact was distinct in the population of oribatids, prostigmatids and pyroglyphids. It may be concluded that the rapid increase of mites population of house dust in summer is affected mainly by not temperature but the moisture content of environmental materials of the mites.

11S-5,29 STUDY OF NUTRITIONAL REQUIREMENTS ON THE SURVIVAL OF DERMATOPHAGOIDES PTERONYSSINUS.

de SAINT-GEORGES-GRIDELET,D. (Dept. Ecologie animale, Univ. Cath. Louvain,
LOUVAIN-LA-NEUVE, 1348 BELGIQUE).

Physical structure of the substrate as well as chemical nature of the components are decisive factors for the house dust mite growth and survival. A lesser reproduction of D. pteronyssinus on rearing media with too fine particles but a faster colonisation on the fine fibrous house dusts prove that the mite prefers an aerated and not dense substrate. On the other hand, D. pteronyssinus can develop on animal material (essentially proteinic) as good as on glucidic vegetable substrate. But in all cases, it seems that its growth depends more particularly on the amount of lipids and vitamins B. All these phenomena are related to the antagonistic effects of xerophilic fungi (as Aspergillus penicilloides). Indeed, since pulverisation increases the hygrometric capacity of a material, it promotes an inhibitory fungal proliferation on the more energetic nutrient media. The antagonism is less marked on the natural substrate which is more heterogeneous physically as chemically. The fungus grows temperately on it: the mycelium is less compact and sporulation relatively decrased. Therefore, in the house dust, at higher humidities (80 %, sometimes 83-85 % H.R.), benefic effects of A. penicilloides remain prevalent since the mites control is easier. In fact the special metabolism of these xerophilic fungi explains most differential behaviors of D. pteronyssinus on all types of food (culture media and natural substrate).

11S-5,30 NUTRITIONAL REQUIREMENTS OF HOUSE-DUST MITES (PYROGLYPHIDAE). Bronswijk, J.E.M.H. van (Lab. Minibiologie, Vakgr. Dermatologie, Rijksuniversiteit, Utrecht, The Netherlands)

Pyroglyphid mites (most commonly of the genera Dermatophagoides, Euroglyphus and Hirstia) are inhabitants of the nests of birds, burrows and dens of mammals,and the house of man. Their relations with the formation of inhalant allergens have made them well known in recent years. All species seem to be dependent on the presence of epidermal material derived from the inhabitant of nest,den or house.But laboratory experiments indicate that any feed will do which containes a considerable amount of protein and 4-6% fatty substances. Fresh skin scales of mammals contain more fat then the mites can handle. More or less xerophilic species of fungi (commonly of the genera Wallemia and Aspergillus) may hydrolize part of these fats, making the skin material edible for the mites. However, under damp conditions fungal growth can quickly become detrimental to the mites. Characters of the food pertaining to texture, packing and amount per mite have a profound influence on the success of a population. These effects are partly nutritional (poisoning of food by growth of microorganisms) and can partly be attributed to the environmental function of the food that usually also serves as living space for the pyroglyphids. A better understanding of the nutritional requirements of house-dust mites and other organisms inhabiting the dust of beds, furniture and floors, would greatly enhance the possibilities for reducing the allergen content of the human home.

11S-5,31 A SIMPLIFIED BASOPHIL DEGRANULATION TEST FOR THE IN VITRO DIAGNOSIS OF HOUSE-DUST MITES ALLERGIES. Mumcuoglu, Y. and Wortmann, F. (Allergy Dept., Kantonsspital Basel, Switzerland)

The basophil degranulation test (BDT) introduced by Shelley (1962) was newly modified based on methods by Benveniste et al. (1977) and Leynadier et al. (1977), both using the ability of basophils to stain with toluidine blue when intact, and to lose this property after degranulation. The method of the two latter authors was combined by us and proved reliable and easily reproducible in the investigation of patients with allergies to house-dust and to house-dust mites. All 20 patients reacted to the mite extracts and 19 out of 20 to the house-dust extracts. Out of 20 control persons, 17 had negative results to the mite extracts and 16 to the house-dust extracts. The advantages and disadvantages of this new method are discussed.

11S-5,32 IMPORTANCE OF HOUSE DUST MITE IN CLINICAL ALLERGY. Miyamoto, T. (Dept. Physical Therapy and Int. Med., Univ. of Tokyo, Tokyo 113 Japan)

House dust mite is one of the most important causative allergen in house dust, though not a single allergen in house dust. This has been shown by skin testing, P-K test, inhalation provocation test, radioallergosorbent test, in vivo and in vitro neutralization test, etc. Common allergenicity has been found among different house dust mites, and allergenic potency of house dust depends largely upon the number of mites contained house dust. Bodies of mites have an identical allergenicity with the excreta. Mite extract has been used for the hyposensitization therapy. The mite extract is generally more potent than crude house dust extract, and produce a higher incidence of adverse reactions than house dust extract unless more than 100 times high dilutions are used. Recently improved methods as denatured mite antigen have been tried in the treatment on experimental bases.

11R-1,1

STUDIES ON MOSQUITO POPULATIONS OF THE SUDAN AND SAHEL SAVANNAS OF NIGERIA.

Gadzama, N.M. (Dept. of Bio. Sciences, University of Maiduguri Nigeria)

From previous studies (Gadzama, 1977), the assessed pupulations of mosquitoes in Zaria, Nigeria agree with that of Sudan Savanna of Bobo-Dioulasso, Upper Volta (Subra. 1970). The greatest number of anophilines caught in this type of Savanna was between the months of August and October. The major species included *Anopheles gambiae*, *An. funestus*, and *An. pharoensis* which, although prevalent in the Sahel zone of Maiduguri, appeared in varied numerical frequencies. *An. pharoensis* and *An. squamosis* constituted the greatest proportion of the anophilines caught in the drier zones.

Culicines are abundant all the year round at the two environmental sites of collection. *Aedes aegypti*, *Ae, vittatus*, *Culex pipiens fatigans*, *C. perfuscus* *C. poicilipes*, *C. annulioris*, *C. tigripes*, and *C. nebulosis* are the most frequently collected. The significance of the mosquitoes and their relative prevelence in the environments are discussed.

11R-1,2

SUCCESION, POPULATION INTERACTIONS AND REGULATION OF MOSQUITO SPECIES IN URBAN ARTIFICIAL CONTAINERS.

Machado-Allison, C.E., Barrera R.R., Rubio, Y., Rodriguez, D. and A.A. Ríos (Inst. Zoología Tropical, UCV, Caracas, Venezuela).

Continuous increase in urban breeding places for mosquitos are a major problem of public health in Caribbean countries. Religeous practices and cultural habits maintain large populations of mosquitos in urban cemeteries. Permanent flower pots tended by mourners, serve as breeding places for *Culex fatigans*, *C. corniger*, *Aedes aegypti*, *Toxorhynchites theobaldi* and other diptera. Decomposition of flowers and stems creates a sequence of habitat types in the pots, a succesion in the dominance of each species and complex interactions. Field and laboratory observations and experiments were performed in order to study density changes, niche overlapping and segregation, competition and predation. A succesion *C. corniger*→*C. fatigans*→*A. aegypti* was observed. However *A. aegypti* is present in pots of every condition. Both *Culex* species decline in density as water clears and particulate matter settles. *T. theobaldi* breeds mainly in dark and old pots. Density increase in June as result of both rains and a special mourning day in middle May. During dry-season months mourners maintain water in 43% of the 190.000 flower pots of one of Caracas cemeteries. *T. theobaldi* preys indiscriminaover *Culex*, *Aedes*, some Psychodids and coespecifics. Motion differences between preys do affect the results and no fitting to Holling' s models was obtained. In laboratory experiments competition between *C. fatigans* and *A. aegypti*, and predatory behavior of *T. theobaldi* were analyzed.

11R-1,3

SALTMARSH MOSQUITO PROBLEMS CAUSED BY INDUSTRIAL DEVELOPMENTS IN AUSTRALIA.

Marks, E.N. (Qld. Inst. Med. Res., Herston, 4006, Australia)

Pest populations of *Aedes vigilax*, *Culex sitiens* and *Anopheles hilli* were associated with engineering activities related to drainage, reclamation and disposal of industrial wastes in the intertidal zone near the cities of Brisbane and Gladstone. Coastal industrial developments are expanding. Can similar problems be prevented?

11R-1,4

MOSQUITOES OF THE SOVIET FAR EAST.

Sazonova,O. (Dept.Zool.,N.K.Krupskaya Moscow Region.Pedagogic. Inst., Moscow,107005,USSR)

The fauna of mosquitoes of the soviet Far East (FE) includes 54 species. 45 species are on the South Primorje, 32-in the Middle Sichote-Alin, 19-in Kamchatka, 17-in Anadyr Lowland, 20-in Kolyma Upland. Such variety of species in Primorje is due to the interpenetration of the two main types of faunas:Siberian, or boreal and Manchurian. The representatives of the first live in the mountain taiga and swamps and the second-are met in broad-leaved forests, lowland grass marshes and on the sea coast (A.nipponicus, A. sibiricus, A. esoensis, C. orientalis, C. vagans, A. togoi). There are also representatives of the Oriental faunistic region (C. tritaeniorhynchus, C. bitaeniorhynchus). In the Middle Sichote-Alin some manchurian and oriental forms pervade to the north along the sea coast, up the mountain rivers (A. togoi, A. Japonicus, A. koreicus, C. bitaeniorhynchus) and dwelling in tree hollows (T. christophi, A. alektorovi). An maculipennis reaches Zeja lowland on the east where it is replaced by an.hyrcanus eastwards, the last is common in Primorje. A. vexans nipponi is widely spread on the FE: from South Primorje to Kamchatka. On the north of the FE the mosquitoes of generas: Anopheles, Culex, Toxorhynchites and subgeneras Finlaya and Stegomyia of Aedes genera disappear. The boreal and tundra-forest species predominate (A. punctor, A. communis, A. hexodontus) there, in some areas tundra species: A. impiger, C. alaskaensis are abundant, sometimes A. nigripes. The majority of northern species are holarctic. Some representatives of american mosquito fauna are discovered there.

11R-1,5

Anopheles farauti in Australia. Mahon, R.J. (Virus Ecol. Res. Gp., Res. Sch. Biol. Sci, Aust. Nat. Univ., Box 475, Canberra City, 2601, Australia)

Members of the *Anopheles punctulatus* Dönitz complex are the most important vectors of malaria in New Guinea and the islands of the region. The taxon *A. farauti*, included in the complex, was shown by Bryan (1973) to consist of two species, *A. farauti* No. 1 and *A. farauti* No. 2, which when crossed produced sterile offspring. Cross-mating techniques, and analyses of the banding patterns of polytene chromosomes from fourth instar larvae, show that *A. farauti* No. 1, *A. farauti* No. 2 and a new species provisionally called *A. farauti* No. 3 are sympatric in Northern Australia. The relationship between the three species will be discussed.

11R-2,6

IDENTIFICATION OF *AEDES COMMUNIS*, *AEDES PUNCTOR* AND *CULEX PIPIENS* AS VECTORS OF ARBOVIRUSES IN THE PROVINCE OF QUEBEC (CANADA), Belloncik, S.[1], Poulin, L.[1], Fauvel, M.[1], Maire, A.[2] and Aubin, A.[2] ([1]Centre de recherche en virologie, Institut Armand-Frappier, Laval, Canada and [2] Dépt. de chimie-biologie, Université du Québec à Trois-Rivières, Canada)

Several serological surveys in the Province of Québec have documented the exposure of humans and animals to arboviruses (Artsob and Spence, 1979). In contrast only one virus strain belonging to the California encephalitis (CE) group has been isolated from *Ae. communis* (Woodall, 1975; personnal communication). The role of different mosquito species in the transmission of arboviruses is still unknown in the province of Québec.

In 1979, field studies were undertaken in a region of Laurentians where human cases of California encephalitis had been previously diagnosed serologically (Fauvel *et al.*, 1980) in order to detect the presence of arbovirus strains as well as to study their persistence and their vector in the area.

Eight seroconversions to the CE virus group were obtained from indicator rabbits in June, July and August 1979 and virus strains were isolated from the sera of viremic rabbits in June and July. 9550 adult mosquitos belonging to ten species were divided into 191 pools and inoculated into suckling mice. Twelve isolates of CE group virus and one isolate of Flanders (first isolation in Québec) were obtained. All the isolates of CE group virus were obtained from *Ae. punctor* (54% of the mosquitoes) and *Ae. communis* (29%) with a field infection rate le 1/1040 and 1/400 respectively. Flanders virus was isolated from *C. pipiens*. Our results demonstrated a high incidence of CE group viruses in an area where human cases occurred previously. Furthermore, an additionnal CE isolate was obtained from a pool of *Ae. communis* adult mosquitoes reared from field-collected larvae in the absence of any vertebrate exposure. These results suggest that *Ae. communis* could play a role in the persistence of CE virus strains in the area studied.

Artsob, H. and L. Spence. 1979. In Arctic and Tropical Arboviruses. Ac. Press 39-65.
Fauvel, M. *et al.* 1980. Canad. Med. Assoc. J. In press.

11R-2,8 SIMPLE PREDICTIVE MODELS OF *AEDES AEGYPTI* (L.) ABUNDANCE IN PUERTO RICO. Moore, *Chester* G. (Cntr. Dis. Contr., San Juan, Puerto Rico)

In Puerto Rico, *Aedes aegypti* (L.) larval indices begin to rise about 4 weeks after the onset of the rainy season, and when virus is present, dengue cases begin to appear from 4 to 8 weeks later. If rainfall is an accurate predictor of vector abundance, then vector control operations could be improved by monitoring rainfall and beginning control before populations increase. A simple model, based on rainfall, was developed to predict field population levels of *A. aegypti*.

Monthly surveys in five cities from 1973 and 1975 furnished the mosquito data set. Rainfall records were from the weather station nearest to each site. The relationship between the Breteau index (positive containers/100 houses) and rainfall was examined by using stepwise multiple regression analysis. Rainfall and number of rainy days during the 1,2...7 weeks before sampling were the independent variables.

Rainfall more than 5 weeks before sampling had little or no effect on larval abundance. The regression coefficients, together with reported rainfall for each of the five study areas, were used to predict the Breteau indices for the same sites during 1976. Continuing monthly larval surveys produced data against which the model was tested. Good agreement was obtained between predicted and observed indices for two south coast communities which have a very pronounced dry season. In the three remaining cities, in which rainfall is less often a limiting factor, correlations were not as high.

Predicted Breteau indices were compared with field observations for the city of Ponce for the years 1976 through 1978. The correlation observed and predicted indices ranged from 0.68 in 1977 to 0.86 in 1976. The model was sufficiently accurate to be used in predicting vector outbreaks in dry areas, where dengue incidence is highest.

11R-2,9 STUDIES ON DENGUE HAEMORRHAGIC FEVER IN THE PHILIPPINES: ENTOMOLOGICAL ASPECTS. *Salazar, N.P.* (Inst. Pub. Health, Univ. of the Philippines, Manila)

An integrated multidisciplinary research project was conducted to obtain baseline information relevant to the epidemiology of dengue haemorrhagic fever in the Philippines during a 12-month period ending in July, 1979. This involved eight collecting stations from four districts of Manila, likewise representing high and low dengue risk areas.

The parameters used for vector surveillance were: indoor resting density; biting/landing rates; parous rates; Breteau index; house index; container index; and larval breeding preferences. Altogether, these observations indicate potential dengue virus transmission by *Aedes aegypti* in an urban setting like the City of Manila. This knowledge will likewise be used in a community-based health education program for *Aedes aegypti* larval control.

11R-3,10 NEW RECORDS OF LUNG MITES IN KOREA
Yong Tai, Noh (Dept. of Biology, Catholic Medical College, Seoul, Korea)

This study is the first report on lung mites of Genus Viperacarus found in the lungs of snake Agkistrodon halys and Natrix tigrina in Korea

11R-3,11 Biochemical and allergenic studies on the house dust mite extract.
Ishii,A.,T.Abe, H.Shimomura and Y.Kabasawa (Dept.Parasit.,Miyazaki Med.Col. and Dept.Paediat.,Tokyo Med.Dent.Univ., Miyazaki 889-16 Japan)

The house dust mite, *Dermatophagoides pteronyssinus* and *D.farinae*, was cultured in a large quantity on powdered animal food and dried yeast. The mite was collected by flotation and homogenized to extract the antigen. The crude extract was fractionated by gel filtration,ion-exchange chromatographies,polyacrylamide electrophoresis,isoelectrofocusing and lectin affinity chromatographies. Allergenic activity of the fractions was measured by radioallergosorbent test and/or skin test. Allergens of the house dust mite fall in molecular weight range of 15,000 to 70,000 and showed heterogeneity by PAGE and isoelectrofocusing of several components and pIs. Quantitatively major allergen is acidic glycoprotein of pI=4.8. Fraction No.2 from Sephadex G-100 gel filtration contains most of allergenic determinants and is used for diagnosis and hyposensitization therapy as a biological product.

11R-3,12 PRELIMINARY INVESTIGATIONS ON THE DETECTION OF BABESIA INFECTION IN THE TICK USING EGG CRUSHING LARVAL SMEARS AND HAEMOLYMPH PUNCTURE APPROACH.
AKINBOADE, O.A., Dept. Vet. Micro. Paras.,Univ. Ibadan

Investigations on detection and estimation of *Babesia* infection rates of *Boophilus* species revealed that:

(a) By egg crushing approach, Babesia infection in cattle is detected in eggs from day 4 and lasts to between 21-24 days before disappearing.

(b) Through haemolymph puncture, infection could only be noticed from the 5th or 6th day to the 16th day.

(c) *Babesia* infection can be detected from day I in the larvae of "infected" ticks. "Un-infected" ticks showing negative egg infection have been found to transmit infection to day 2 even though the percentage is comparatively low.

11R-4,13 LABORATORY STUDIES ON FACTORS INFLUENCING THE OVIPOSITION AND ECLOSION PATTERNS OF FEMALE *AMBLYOMMA VARIEGATUM* (FABRICIUS, 1794). OGUNJI, F.O.,
Dept. Vet. Micro. Paras., Univ. Ibadan, Nigeria.

The factors which may affect the oviposition and eclosion of engorged *Amblyomma variegatum* on the field such as moisture, wind and environmental physical structures were inmitated in the laboratory. When engorged ticks were forced to rest in abnormal positions during the preoviposition and oviposition periods, the numbers of eggs they produced were significantly higher than when they rested in the normal position. The same observation of significant higher numbers of eggs was made when engorged ticks were subjected to effects of artificial wind and when they were exposed to moisture for period of ½ hour, 1 hour, 2 hours and 3 hours. In none of these observations was there a significant difference in the preoviposition, oviposition and preeclosion periods. Ticks which were deformed by cutting off their first pair of legs produced the same range of eggs with the normal ticks; however, the preoviposition period of the deformed ticks was significantly prolonged.

11R-4,14

SEX PHEROMONE REGULATION OF MATING BEHAVIOR IN THE CAMEL TICK *HYALOMMA DROMEDARII* KOCH (ACARI: IXODIDAE). Khalil, G. M., Nada, S. and Sonenshine, D. E. (Med. Zool. Dept. NAMRU-3, Cairo, Egypt)

Bioassays performed on rabbit hosts demonstrate the presence of a female sex pheromone in *Hyalomma dromedarii*. The pheromone is emitted within a few days after females attach to the host and diminishes following mating and repletion. The threshold for sex pheromone release is reached when attached females attain a weight of 8 mg; maximum release occurs when attached female body weight is $\geq$ 16 mg. Males become sexually active within a few days after attaching to the host. Sexually active males respond similarly to 2,6-dichlorophenol and to the natural pheromone. The magnitude of response is related to the pheromone concentration. Bioassays indicate the foveae dorsales as the sites of pheromone release.

11R-4,15

Congo virus - The development in the Ixodid ticks - *Hyalomma rufipes* Koch and *Amblyomma variegatum* Fabricius by Okorie T.G., Virus Research Laboratory, University of Ibadan.

Congo virus has been shown to be antigenically indistingishable from the etiologic agent of Crimean haemorrhagic fever, a serious and often fatal disease in man in U.S.S.R. and Bulgaria.

All stages of ticks, except larvae of *H. rufipes* were infected intracoelomically, with a virus concentration of 3.5 mouse LD_{50}, 1.5 MLD_{50} and 0.5 MLD_{50} for infection threshold studies, and 3.5MLD_{50} for trans-stadial development studies.

There was evidence of virus replication in all the stages of ticks inoculated with 3.5 MLD_{50} and 1.5MLD_{50} in both ticks. The peak titres obtained in the immature stages of larvae and nymphs were higher than those obtained in adults. Congo virus infection acquired in the larval or nymphal stage persisted during metamorphosis and was passed on to the next generation. Transovarial transmission of Congo virus occurred in *H. rufipes*. Both *H. rufipes* and *A. variegatum* transmitted Congo virus to rabbits during feeding, after inoculation of larvae or nymphs with a virus dose of 1.5MLD_{50} or 3.5MLD_{50}.

11R-5,17

THE BLOOD SUCKING ARTHROPOD FAUNA OF SINAI DESERT. Braverman, Y., Frish, C. and Rubina, M. (Dept. Ent. Kimron Vet. Inst. POB 12, Beit-Dagan 50200, Israel)

Blood sucking arthropods were collected in 61 localities in Sinai including oasises, sea shore swamps, Beduin dwellings, animal enclosures and army camps, areas with average annual precipitation from 10 to 100 mm. The following species were found: *Culicoides*: *pulicaris* gp; *newsteadi*; *schultzei* gp; *circumscriptus*; *langeroni* gp; *imicola*; *agathensis*; *cataneii*; *distinctipennis*; *puncticollis*; near *maritimus*; *coluzzii* and 12 other unidentified species. *Culex*: *pipiens* complex; *mimeticus*; *deserticola*; *univittatus*; *laticinctus* and *adairi*. *Aedes*: *caspius* and*detritus*. *Anopheles*: *multicolor*; *superpictus* and *sergenti*. *Culiseta longiareolata*. *Uranotaenia unguiculata*, *Leptoconops* spp. and *Phlebotomus* spp. were also caught. *Hippobosca camelina* louse flies were found on camels, *Hippobosca longipennis* on dogs and *Lipoptena chalcomelaena* on goats. The following ticks were found: *Hyalomma dromedarii*; *H. excavatum*; *H. impeltatum*; *H. marginatum*; *H. schltzei* and *H. Sinaii* on camels, *Rhipicephalus sanguineus* on sheep and dogs, *Ornithodorus savignii* on the ground and *Argas persicus* on chickens. The data on the various species were analyzed quantitatively.

11R-5,18 PHLEBOTOMINE SANDFLIES OF SAUDI ARABIA. Büttiker W. and Lewis D.J.
Address: P.O. Box 5770, Riyadh (Saudi Arabia).

21 species of Phlebotomini were found representing palaearctic and afrotropical taxa, and including eight species of Phlebotomus (Lewis and Büttiker, 1980). P. papatasi and P. sergenti are well known vectors of dermal leishmaniasis. P. alexandri and P. kazeruni are suspected of playing some part in transmission among rodents. P. bergeroti and P. saevus are probably too rare to be significant. P. orientalis and P. chinensis arabicus may transmit kala-azar and are localised in a few upland areas of the southwest. Dermal leishmaniasis is widespread in the desert belt from the northern to the central and southeastern districts of the country. An epidemic of oriental sore has been described from Hofuf (Büttiker and Lewis, 1979). In most parts of S. Arabia kala-azar is rare or absent and the reservoir is unknown. The Naples and Sicilian strains of sandfly fever are known and are doubtless transmitted by P. papatasi. Further investigations are in progress (Tesh et al., in prep.). A large-scale housefly control programme produced a very sharp reduction of the urban sandfly population monitored in three towns (Büttiker, 1980).

References: Büttiker W., 1980. Fauna of Saudi Arabia, 2.
Büttiker W. & Lewis D.J., 1979. Tropenmed. Parasit. 30: 220 - 229.
Lewis D.J. & Büttiker W., 1980. Fauna of Saudi Arabia 2.
Tesh R.B., Keir M. & Büttiker W., in prep. Fauna of Saudi Arabia 3.

11R-5,19 CULICOIDES FAUNA OF MALAYSIA AND ITS ENZOOTIC SIGNIFICANCE IN THE PACIFIC AREAS (DIPTERA: CERATOPOGONIDAE). Kitaoka, S. (Natl.Inst.Anim.Hlth., Tsukuba, 305 Japan)

Extensive light-trap collections of biting midges of the genus Culicoides were carried out in peninsular Malaysia, Sabah and Sarawak from 1977 to the present time. More than 60 species were collected and the known number of species identified almost double those of the former records. It is postulated that some of the dominant species in the South East Asian areas spread outwards the fauna and now consists of the Oriental species and the ones of veterinary importance in Japan and Australia. This thought is supported the finding of antibodies in cattle in intervening areas against viral disease, which are primarily found in Japan and Australia.

11R-5,20 DISTRIBUTION OF BLACK FLY (SIMULIUM OCHRACEUM) IN GUATEMALA AND ITS RELATION TO GEOLOGICAL CONDITIONS. Yamagata, Y. (Dept. of Agr. Biol., Univ. of Tokyo, Tokyo 113, Japan), Okazawa, T. (Dept. of Zool., Hokkaido Univ., Sapporo 060, Japan) and Molina, P. A. (Servicio Nacional de Erradicación de la Malaria, Zona 11, Guatemala, Guatemala)

Distribution of S. ochraceum, the main vector of human onchocerciasis in Guatemala and Mexico, was studied in Municipios de San Vicente Pacaya and Palín, Departamento de Escuintla, Guatemala. Larvae were found to breed in small streams with the water discharge between 0.1 and 10 l/sec. and the inclination in more than 5 degrees, which are found almost exclusively in the tertiary volcanic terrain. Water permeability is lowere in the tertiary terrain than in the adjacent quaternary volcanic and aluvial terrains.

According to Dalmat (1955), onchocerciasis zone was situated in the foothill region of Sierra Madre, the volcanic range. But the present survey could locate the endemic foci on the slopes of ancient terrain where the original volcanic topography was highly eroded, and not in the foothills of recent volcanoes.

11R-5,21 SUSTAINED COLONIZATION OF A MULTIVOLTINE *SIMULIUM* BLACK FLY.

Simmons, K., Edman, J. (Dept. Ent., Univ. Massachusetts, Amherst, Ma., 01003, USA)

The Eastern North American Black Fly *Simulium decorum* has been maintained in laboratory colony continuously since June 1978 -- now over 15 generations. High rates of larval survival and adult female insemination and oviposition are readily achieved in the laboratory but low hatch rates of embryonated eggs after storage still hamper rearing efficiency. Though autogenous for the initial egg batch, both nulliparous and parous females can be induced to blood feed in the laboratory and 25% can support development of the bovine nematode *Onchocerca gutturosa* to the infective 3rd larval stage. Current methods for maintaining this black fly colony are outlined.

11R-6,22 Ecological Observations on *Simulium irakae* Smart (Diptera, Simuliidae), a little known Middle Eastern Blackfly.

Abul-hab, J. (Entomology, Prot. Res., Abu-ghraib, Iraq)

Simulium irakae Smart (Diptera, Simuliidae) is a little known black-fly from the Middle East. It was discovered in Iraq and described 1921. It is here rediscovered in large numbers. It was found to constitutes a great nuisance in al-Anbar Province in Central Iraq. Its probable breeding places are in large masses of water, i.e. rivers which are moderately fast running and not very cold. It was found feeding on donkeys and cattle. The males of this species are still unkown. Only a few larvae were found and no pupae.

11R-6,23 BIOLOGY AND CONTROL OF *DERMATOBIA HOMINIS* (DIPTERA; CUTEREBRIDAE).

Moya Borja, G.E. (Univ. Fed. Rural do Rio de Janeiro, Km 47 Rio-S. Paulo, Brazil)

D. hominis is a common important parasite of cattle in tropical areas of Latin America. The biology and control of this parasite were studied at the Universidade Federal Rural do Rio de Janeiro, Brazil, under laboratory conditions. *Dermatobia* Females used *Cochliomyia hominivorax*, *Stomoxys calcitrans*, *Musca domestica* and *Ceratitis capitata* adults as vectors of their eggs. Eggs developed in one week; the larval period ranged from 30 to 46 days depending of the host (mice, rats, guinea pigs, rabbits or calves). The pupal periods for males and females were 30 and 32 days; the adult longevity was 3-4 days. Sexual sterility was induced with gamma radiation. The sterilization doses for females and males were 10.0 and 12.5 Kr. Similar results were obtained treating the adults by tarsal contact with Tepa and Thiotepa. *Dermatobia* adults infested with *Macrocheles muscadomesticae*, a phoretic mite, failed to copulate or capture the vectors for oviposition.

11R-6,24 ACTIVITY OF AVERMECTIN FRACTIONS AGAINST *LUCILIA CUPRINA* LARVAE.

Butler, R.W and Picton, J. (MSD (Australia) Pty. Limited, Box 135 P.O. Ingleburn, N.S.W 2565, Aus)

The activity of some components of the Avermectins against *Lucilia cuprina* larvae has been recorded by James, Picton and Riek (*Vet. Rec:*in press).

In a pen trial five purified components used as applications to the wool and skin of sheep have given protection against artificial implants of *L. cuprina* larvae for periods of up to 22 weeks.

One component has shown activity against *L. cuprina* larvae when administered to sheep orally or by subcutaneous injection.

11R-6,25 SOME ASPECTS OF OOGENESIS IN THE MATED AND VIRGIN STABLE FLY, *STOMOXYS CALCITRANS* L. (DIPTERA: MUSCIDAE).

Venkatesh, K., Morrison, P.E. (Dept Biology, University of Waterloo, Waterloo, Ontario, N2L 3G1 Canada)

In the female stable fly, *Stomoxys calcitrans* L. mating is not required for oogenesis, but is necessary for oviposition. Virgin females develop eggs but, in the absence of mating, they retain eggs until death. Mated females exhibited a cyclical pattern of blood ingestion whereas no such cyclicity was observed in virgin females due to egg retention. The penultimate follicles develop and deposit upto 50% yolk before the terminal follicles are matured. However, further development of these follicles depend on oviposition of matured eggs and the number of blood meals. Implantation of male accessory glands initiated oviposition in virgin females.

11R-6,26 ENDOCRINE CYCLES DURING PREGNANCY IN *G. austeni* (NEWST)

EJEZIE, G. C. (Natl. Inst. Med. Research, Yaba, Nigeria)

Cyclic changes occur in the histological appearance of median neurosecretory cells and corpus allatum of females of *G. austeni*. These changes are related to physiological events occuring during pregnancy, such that neurosecretion is held to govern ovulation and larviposition in mated females.

The development of the oocyte which will become the progeny in the next pregnancy proceeds in synchrony with the cycle of milk synthesis. Surgical removal of the corpus allatum combined with juvenile hormone replacement therapy strongly suggest that juvenile hormone governs the synthetic activity of the milk gland and the previtellogenic stages of oogenesis.

A preliminary study of the effects of precocene II on these events, via the allatum hormone, was inconclusive.

11R-7,27 HOST-FEEDING PATTERNS OF CULEX ANNULIROSTRIS SKUSE IN AUSTRALIA.

Kay, B.H. and Boreham, P.F.L. (Queensland Institute of Medical Research, Brisbane, Australia)

The mosquito, Culex annulirostris is the major vector of arboviruses, including Murray Valley encephalitis (MVE) virus in Australia. Feeding patterns, as determined by the precipitin test, were compared at Kowanyama, in monsoonal northern Queensland and at Charleville in arid south western Queensland over three year periods. Culex annulirostris appears to be an opportunistic feeding mosquito, feeding primarily on mammals, in particular dogs, cattle, horses and wallabies. No seasonal shifts in feeding were detected but variations were attributable to host abundance and availability. In both localities, dogs may be acting as zooprophylactic agents in reducing feeding on man. Since birds appear to be relatively unimportant hosts, their roles as sentinels and as the major vertebrate host of MVE virus need reevaluation.

11R-7,28 HATCHING RATES OF EGGS IN CULEX PIPIENS MOLESTUS AND CX. P.QUINQUEFASCIATUS AT VARIOUS TEMPERATURES.

Oda, T. and Mori, A.(Dept. Med. Zool., Nagasaki Univ.School of Med., Nagasaki, 852 JAPAN)

In Japan, the mosquito of Culex pipiens molestus, a member of **Culex** pipiens complex, is said to be distributed in parts of Japan lying north of Kagoshima, but not in more southern parts such as Okinawa. However, in the latter parts, there is the mosquito of Cx. p. quinquefasciatus, another member of the same complex as Cx. p. molestus. In our experiments, Cx. p. molestus and Cx. p. quinquefasciatus females which emerged at various temperatures were allowed to lay eggs, and hatching rates of these eggs were examined. At high temperatures, hatching rates of Cx. p. molestus were very low, but in Cx. p. quinquefasciatus they were high. High temperature seems to be at least one of the factors inhibiting the mosquito of Cx. p. molestus to invade the southern parts of Japan.

11R-7,29 REGURGITATION AND SALIVATION IN AEDES AEGYPTI,

P. Jerome, N. Aguocha and H. Lipke, Biology Department, University of Massachusetts/Boston, Dorchester, MA 02125 U.S.A.

Tritiated water (HTO) was imbibed via admixture with fresh whole blood offered in membranes from sheep intestine. Equilibration with body fluids was rapid, only 20% was incorporated into non-volatile metabolites in 28 hr. Provision of a second unlabelled blood meal transferred isotope from radioactive body fluids to the supplementary liquid repast as saliva and regurgitated material. Expectoration and recycling of gut contents was recorded not only with whole blood but also with ATP-fortified erythrocyte, plasma or sucrose solutions. Blood intake via membrane was of the same order as animals feeding on living hosts and transfer of HTO to later meals declined with subsequent feeding. Since expelled HTO could derive either from saliva or gut in the course of a second feeding, intestinal contents were labelled with inulin, an indigestible polysaccharide not utilized by Aedes (Galun & Fraenkel J. Cell Comp. Phys. 50:1(57). Contamination of mouthparts with labelled blood was minimized by washing between feedings. Meal size was quantified gravimetricláy and radiometrically. That regurgitation was not an artefact of contaminated fascicles was demonstrated by the lack of correlation between second meal volume and regurgitation volume since probing alone would contribute significant label to the second meal. The amount of radioactivity ejected, furthermore, was a function of the size of the first meal whereas lebelling from contaminated mouthparts would equalize regardless of the duration of the first repast. Finally, regurgitation of inulin diminished with time, in register with passage of the blood meal down the digestive tract.

11R-7,30 ACOUSTIC ATTRACTION OF MOSQUITO MALES. Ikeshoji, T. (Dept. of Agr. Biol., Univ. of Tokyo, Tokyo 113)

It has been known for long that the flight sound of female mosquitos attracts males. Nevertheless, little trials have been done to apply this findings into a practical control or assessment measures of mosquito populations in the fields. This purpose in mind, I have reinvestigated this with three species. When a 480-Hz sinusoidal sound generated at the bottom of a 100-ml beaker for 15 min every hour by an audio frequency oscillator, all 100 males of *Aedes aegypti*, which were accommodated with 100 females in a cage, were trapped on a sticky ribbon lined on the inside-wall of beaker in 3 days. The males could inseminate only 5-10% of the females before being trapped. A 350-Hz sound was also competed well with the females of *Anopheles stephensi* against the males, leaving only 20-30% inseminated females before all males were trapped in 5 days. On the contrary, 100% females of *Culex pipiens molestus* were inseminated albeit complete elimination of the males by a 400-Hz sound in 3 days. Extirpation experiments of the male antennae or the female wings, and blinding the males with black ink suggested that *C. p. molestus* depends on vision for their mating. No chemical factor seemed to be involved in mating of these species.

11R-8,32 SELECTION OF *AEDES AEGYPTI* LARVAE FOR RESISTANCE TO THREE INSECT GROWTH REGULATORS.

Chong,Eng Li.(Dept.Zool.,Univ.Malaya,Kuala Lumpur,Malaysia.)

Fourth-instar larvae of *Aedes aegypti* were selected for resistance to methoprene, hydroprene, and diflubenzuron for nine generations, at the LC_{50} to LC_{60} level. The LC_{50} values for all three compounds were determined in each generation. In the first generation, the LC_{50} values obtained were 0.0010 ppm for methoprene, 0.0008 ppm for diflubenzuron and 0.68 ppm for hydroprene. The values tended to fluctuate in subsequent generations. The final LC_{50} values in the ninth generation for methoprene was 2.5 x the original value; for hydroprene it was 4.4 x , and for diflubenzuron, 8 x the original value.

11R-8,33 A CELL CULTURE METHOD FOR A NON-HEMATOPHAGOUS MOSQUITO, *Toxorhynchites amboinensis*

Kuno, G. (Center for Disease Control, San Juan Labs., San Juan, Puerto Rico 00936)

Although many cell lines of hematophagous mosquitoes are available, very little is known about the cell culture of non-hematophagous mosquitoes. When minced larvae of *Toxorhynchites amboinensis* were used as the source, no cell line could be obtained. However, with the use of mechanically incapacitated, but living larvae ("incapacitated" larvae) more than 15 cell lines were readily obtained. The presence of "incapacitated" larvae in the tubes until the eighth week was found to be critically important for the prolonged survival of the attached cells and ultimately for the successful isolation of the cell lines. There was an inverse relationship between the number of "incapacitated" larvae in the cultures and time to subculture; increasing the number of larvae from 3-4 per tube to 6 or more per tube reduced subculture time considerably.

11R-8,34 SOME INFLUENCES OF THE MICRO-HABITAT ON THE PREVALENCE, DISTRIBUTION AND FECUNDITY OF HUMAN HEAD LICE (PEDICULUS HUMANUS CAPITIS). Maunder, J.W. and Bain, I.L. (Dept.Ent. Lond. School of Hyg. and Trop. Med. London, U.K.

The widespread assumption that hair length is a major factor in the distribution pattern of head lice is challenged by field and laboratory observations. Evidence is presented to show that characters such as hair shaft diameter, cross-sectional profile, degree of curl and spacing of hair roots have a more profound influence on the reproduction, survival and transmission of this parasite.

11R-9,35 THE BIONOMICS, BEHAVIOUR PATTERNS AND VECTORIAL STATUS OF ANOPHELES KOLIENSIS (DIPTERA: CULICIDAE) IN PAPUA NEW GUINEA. Spencer, Margaret. (Papua New Guinea).

Less is known about Anopheles koliensis than about the other members of the punctulatus group of malaria vectors. Recent work has increased our knowledge of the bionomics, behaviour patterns and vectorial status of Anopheles koliensis in Papua New Guinea. Recent work and the earlier investigations in West Irian and the Solomon Islands are reviewed.

11R-9,36 THE EFFECT OF FANSIDAR ON GAMETOGENESIS AND SPOROGENESIS OF PLASMODIUM FALCIPARUM (THAILAND STRAIN). Sucharit, S., Chomcharn, Y. and Surathin, K. (Dept.Med.Ent.,Fac.Trop.Med., Mahidol Univ., Bangkok 4, Thailand)

The studies on the effects of Fansidar in patients on gametocytes, oocyst and sporozoite infection in Anopheles stephensi were done at Cholburi Province, Central Thailand, where chloroquine-resistant Plasmodium falciparum is prevalent. A single dose of two tablets of Fansidar given to P.falciparum patients was effective to asexual stage but this dose stimulated gametocytogenesis and sporogony for 2 weeks. The three tablets reduced gametocytogenesis, oocyst production but these reductions did not affect on sporozoite rates.

11R-9,37

INTRA- AND INTERSPECIFIC ASSOCIATION OF DAYTIME-RESTING ADULT MOSQUITOES IN THE PADDY AREA. Karoji, Y. (Kyoto City Research Institute of Public Health, Kyoto 604, Japan)

Several species and their components (males, females and several stages of the gonotrophic cycle of the female) of adult mosquitoes resting during the daytime in vegetation in the paddy area usually showed contagious distribution (Karoji, 1980). I analyzed next whether such mosquitoes coexisted at their resting sites or not. Collections of mosquitoes were made once a week in the daytime during the mosquito season in 1973 and 1974 in a paddy area located at the southern part of Kyoto, Japan. Sampling cages and a suction catcher were used for capturing mosquitoes within quadrats set in the study area. R_δ-index (Morisita, 1959) was used for analyzing the degree of intra- and interspecific correlation of the mosquitoes *Culex pipiens pallens*, *C. tritaeniorhynchus* and *Anopheles sinensis* which were the dominant species among the samples collected. R_δ between the species or the components was calculated based on the catches at every quadrat in a sampling day. As the result, many of R_δ was larger than zero irrespective of species, sex and physiological age meaning that the daytime-resting mosquitoes coexisted ordinarily at their resting sites.

11R-9,38

ENTOMOLOGY OF LOW COST SANITATION IN THE TROPICS. Laurence, B.R. London School of Hygiene and Tropical Medicine, U.K.

The United Nations International Drinking Water Supply and Sanitation Decade is due to begin in 1981. The provision of sanitation to human populations in the tropics will provide new non-seasonal breeding habitats for insects of medical importance. The suitability of various low cost sanitation units available for tropical countries will be compared and the entomological problems associated with them.

11R-10,39

PREDATORY MOSQUITO LARVAE AS BIOLOGICAL CONTROL AGENTS OF MOSQUITOES IN NIGERIA.
Matanmi, B. A. (Dept. Plant Science, Univ. Ife, Ile-Ife, Nigeria).

Predatory mosquito larvae had been earlier recorded from several locations in Nigeria although very little or no effort has been devoted to the detailed investigation of these species as biological control agents of vectors. In this study, *Toxorhynchites brevipalpis conradti* Grünberg and *Culex* (*Lutzia*) *tigripes* Grandpré and Charmoy were recorded as predators of *Aedes aegypti* (Linnaeus), *Anopheles gambiae* Giles, *Culex quinquefasciatus* Say (=*C. fatigans* Wied.), and *Eretmapodites chrysogaster* Graham in the Ile-Ife area of Nigeria. *T. brevipalpis* was also found to be a hyperpredator of *C. tigripes*. The results of preliminary investigations by the author would suggest that *T. brevipalpis* shows considerable promise as biological control agents of container-breeding mosquitoes in Nigeria. Even though the growth rate was rather low and its spread appeared to be limited in this study, the author opines that the recent mass production techniques developed for this and other species in other parts of the world can be utilized in effecting multiple inundative releases.

11R-10,40 EFFECTIVENESS OF THE NEMATODE, NEOAPLECTANA CARPOCAPSAE AS A BIOLOGICAL CONTROL AGENT FOR THE MOSQUITO LARVAE (CULEX PIPIENS QUINQUEFASCIATUS AND AEDES AEGYPTI)IN THAILAND.

Wongsiri, S. (Dept. of Bio., Chulalongkorn Univ., Bangkok Thailand.

With the development of increasing insecticide resistance of mosquitoes due to chemical control measures, scientists are intensifying their search for biological control agents.

The study of biological control of mosquito larvae in the laboratory showed the efficiency of the nematode, Neoaplectana carpocapsae in the control of mosquito larvae, Culex pipiens quinquefasciatus Say. and Aedes aegypti L. The results showed that the first, second, third, fourth instar and pupal stage of mosquito larvae of C. p. quinquefasciatus were reduced to 74.6%,66.6%,58.7,44%, 74% respectively by a proportion of 1 mosquito larvae : 200 nematodes. On the other hand, the control of the different stages of mosquito larvae of A. aegypti, were 30%, 86.6%, 73.3%, 39.3% and 9.3% respectively by the proportion of 1 mosquito larvae : 200 nematodes.

11R-10,41 STUEIES ON BACILLUS THURINGIENSIS VAR. ISRAELENSIS.

Goldberg, L.J., Ford, I. (Nav. Biosci. Lab., Univ. California,
Berkeley, CA. 94720, U. S. A.)

Successful field application of Bacillus thuringiensis var. israelensis (B.T.I.) as a larvicide will require the development of a standardized, stable and optimally formulated preparation. Coupled with such development is the requirement of providing an estimate of required field application rates.

The authors have developed a bioassay procedure based on a defined laboratory aquatic test system which provides for toxicity standardization. Additionally, data has been obtained suggesting a procedure to estimate required rates of field application. Data will also be presented on a microencapsulated formulation which results in a buoyant colloid, thus stabilizing the entomotoxin within the upper surface water layer. Such a formulation should optimize larvicidal activity by minimizing problems associated with aquatic settling following field application.

A dosage mortality relationship as a function of time period of larval feeding with also be presented in order to clarify requirements for an optimal larvicidal colloidal size distribution.

11R-10,42 HYBRIDIZATION STUDIES ON SIBLING SPECIES OF THE ANOPHELES GAMBIAE COMPLEX UNDER LABORATORY CONDITIONS.

Okereke, T.A. (Department of Biological Sciences, University of Benin, Benin City, Nigeria)

Assortative mating amongst mosquitos of the Anopheles gambiae complex which occur sympatrically in West Africa is investigated in laboratory mating-choice experiments by use of dieldrin resistance and hybrid sterility as genetic markers.

In experiments involving An. gambiae and An. arabiensis mating was found to be assortative while experiments involving the caging in turn of An. gambiae and An. arabiensis with An. melas failed to show the presence of mating barriers known to operate in nature.

Similar mating-choice experiments aimed at demonstrating the presence or otherwise of mating barriers between hybrid females produced in the laboratory and wild (parental) males showed an absence of mating barriers between these types under cage conditions.

11P,1

ASSESSMENT OF THE POTENTIALITY OF THE LARVIVOROUS FISH, GAMBUSIA AFFINIS BAIRD & GIRARD, AS A BIOLOGICAL CONTROL AGENT AGAINST THE EGYPTIAN MOSQUITO, CULEX PIPIENS L. Gaaboub, I. A., Rawash, I. A., Badawy, H. K. and Bayomi, N. A.(Entomology Division, Faculty of Agriculture, University of Alexandria, Alexandria, Egypt)

The ability of different ages and sex of Gambusia affinis Baird & Girard to consume different larval instars, pupae and egg-batches of Culex pipiens L. has been studied under laboratory conditions. This achievement entailed rearing a culture of this fish and covered one brood. Effect of food on gestating period and reproduction of females was also investigated.

11P,2

COMPARISON BETWEEN THE USE OF GAMBUSIA AFFINIS BAIRD & GIRARD, MOSQUITO LARVAE OF CULEX PIPIENS L. AND THE MICROCRUSTACEAN DAPHNIA MAGNA STRAUS AS BIOASSAY TEST ORGANISMS FOR THE DETECTION OF INSECTICIDE RESIDUES IN THEIR HABITATS. Gaaboub, I. A., Rawash, I. A., Badawy, H. K. and Bayomi, N. A. (Entomology Division, Faculty of Agriculture, University of Alexandria, Alexandria, Egypt)

The early fourth instar larvae of Culex pipiens L., individuals of Gabusia affinis Baird & Girard and youngs of the microcrusracean Daphnia magna Straus were tested under standardized conditioms as bioassay test organisms for the preparation of the log concentration-probit regression lines for DDT. According to the LC_{50} values, DDT was toxic to G. affinis, mosquito larvae and D. magna, respectively in a descending order. D. magna proved to be more sensitive to DDT than C. pipiens and G. affinis; it succumbed to concentrations ranging from 0.1 to 0.0008 p.p.m., while both C. pipiens and G. affinis were affected by concentrations ranging from 2.5 to 0.1 p.p.m.

11P,3

ANOPHELES ATROPARVUS VAN THIEL (DIPTERA, CULICIDAE) IN EAST YUGOSLAVIA.

Adamović, Ž. (Inst. Medic. Research, Beograd, PB 721, Yugoslavia)

The distribution and abundance of Anopheles atroparvus, a potential vector of human plasmodia and arboviruses, were surveyed in Serbia and Macedonia, east Yugoslavia. This anopheline was found in almost all the lowlands of the examined area. However, it was a conspicuously abundant species only in the areas with saline and alkaline soils of the Pannonian Plain, in north Serbia, and in a widely separated and limited area of saline soil including the lake Oblačinsko Jezero and some smaller saline ponds situated west of the town Niš in central Serbia. This is probably caused by the relatively high concentration of dissolved salts in the stagnant and slowmoving waters of these areas. - There are saline and alkaline soils in Macedonia, particularly in the plain Ovče polje. However, A. atroparvus was a rare or extremely rare species in the lowlands of Macedonia, which is probably associated with the very hot and dry summars experienced in this area.

11P,4 EXPERIMENTAL INFECTION OF JAPANESE MOSQUITOES WITH DENGUE-2 VIRUS.

Eshita, Y., Kurihara, T. (Dept. Parasit., Teikyo Univ. Sch. Med., Tokyo 173 Japan), and Ogata, T. (Dept. Virol. Rickettsi., NIH, Tokyo 141 Japan)

The possibility of mouse-adapted dengue-2 virus multiplication in female mosquitoes of 14 species found in Japan was studied. The mosquitoes, members of the *Aedes*, *Armigeres*, *Culex*, *Tripteroides*, and *Anopheles* genera, were fed orally and incubated at 30°C. All assays in the present study were done with suckling mice, each inoculated intracerebrally with 0.02ml of ground suspension of 10 pooled virus-exposed females. It was found that of the 14 species *Aedes riversi*, *Ae. flavopictus* and *Ae. dorsalis*, as well as *Ae. albopictus*, had harboured the virus after an eclipse phase. Further experimental study of virus transmission with these mosquitoes is now indicated.

11P,5 MATHEMATICAL MODEL FOR JAPANESE ENCEPHALITIS EPIZOOTIC

Maeda, O. (Kyoto City Research Institute of Public Health, Kyoto,604 Japan)

Mathematical model of Japanese encephalitis epizootic, with some equations of cyclic infections between pigs and mosquitoes is made, containing some parameters such as number of daily mosquito bites, time-course of infection rates of mosquitoes engorged on viremic pig, daily mosquito survival probability, time-course of mosquitoes coming for bites after their gonotrophic cycle and etc. which were given from the actual data. Assumptive epizootics which spread from original infections of a few pigs in a susceptible pig population including 5,000 pigs, are calculated from the equations. Patterns of the assumptive epizootics are similar to the actual patterns, being compared by time-course of infection rates of mosquitoes engorged on the pig population. Some factors affecting the epizootic, such as mosquito abundance, synchronization of the epizootic with peak of mosquito prevalence and rate of mosquito bites from other blood sources than pigs, are discussed in comparison of numbers of infective bites, which are probably correlated to the scale of human epidemic.

11P,6 GENETICS OF *Anopheles stephensi*

Sharma, V.P. (Mal. Res. Cent., 22 Sham Nath Marg, Delhi-54)

Anopheles stephenesi is an important vector of malaria in the Indian sub-continent and the middle east. Genetic studies with the phenotypic markers in *A. stephensi* type form revealed that red-eye is a sex linked recessive mutant while *colorless-eye*, *green-larva* and *greenish-brown* larva are recessive autosomal mutants. It also was revealed that *A. stephensi* has X, Y sex-determining mechanism as in *Drosophila*. Linkage studies have shown that there are 3 linkage groups i.e. linkage group I ingolving sex-linked genes, and linkage group II and III involving, autosomal genes. Studies on the inheritance pattern of dieldrin resistant gene revealed that both complete and incompletely dominant genes are present in the Indian populations.

11P,7

OVARIOLAR PHASES OF CULEX PIPIENS MOLESTUS DURING OOGENESIS.

ABDELGHAFFAR, H. & SHALABY, A.M., ALEX. UNIV., FAC. OF SCIENCE, ALEXANDRIA, EGYPT.

Investigations of the progressive changes in the ovary and ovarioles of Culex molestus Forsk. during oogenesis suggested the presence of seven distinguishable phases I-VII. Descriptive illustrations rendered it possible to define the ovariolar condition of the female by mere observation of the abdomen as seen externally. Although there are characters in common in the Christopher's (1911) five and Sella's (1920) seven arbitrary phases, yet they seemed to be dissimilar in a number of respects.

11P,8

STUDIES ON THE TOXICITY OF THE SYNTHETIC JUVENILE HORMONE, METHOPRENE, TO MOSQUITOES, AEDES AEGYPTI AND CULEX PIPIENS QUINQUEFASCIATUS.

Wongsiri, S. & Thavara, U. (Dept. of Bio., Chulalongkorn Univ., Bangkok Thailand.)

The synthetic juvenile hormone selected for the present study is methoprene (isopropyl (2E, 4E) - methoxy - 3, 7, 11 trimthyl-2, 4 dodecadienoate, trade name - Altosid R SR-10). The results show that methoprene could inhibit growth of larvae to the adult and caused mortality. There was significant defference of mortality between Ae. aegypti larvae and C. p. quinquefasciatus larvae ($P>0.05$). Aedes larvae were less susceptible than Culex larvae. High concentration of methoprene was used in the dosage-mortality test in order to calculate the percentage mortality that occurred during different stages of mosquito development. These data revealed that mortality of C. p. quinquefasciatus occurred mostly at the larval stage whereas mortality of Ae. aegypti occurred in larvae, pupae or adults depending on ages of treated larvae. The results of the tests revealed that the susceptibility of Ae. aegypti larvae to methoprene appeared to increase from the 1st to the 4th instar larvae. The LC_{50} values for 1st, 2nd, 3rd and 4th instar larve of Ae. aegypti were 0.42, 0.25 0.031 and 0.0018 ppm and that of C. p. quinquefasciatus larvae were more susceptible, with the LC_{50} values of 0.021, 0.02, 0.001 and 0.0019 ppm respectively. For treatment of the pupal stage of both species, methoprene failed to inhibit adult emergence. Toxicity of methoprene in canal water to C. p. quinquefasciatus as decreased when compared to a similar experiment using tap water. There was significant difference of mosquito mortality in canal water and tap water ($P>0.05$).

11P,9

DEVELOPMENT OF A STANDARDIZED TEST METHODOLOGY FOR PEDICULICIDES.

Gerberg, E.J., Todd, R.G. and Bernstein, D.F. (Insect Control & Research, Inc., Baltimore, Md.21228, USA)

In the development of a standardized test methodology, biological variables must be identified, characterized and minimized. Experimental results indicate variability due to age, of nymph and adult lice (Pediculus h. humanus) and length of time from oviposition to treating of eggs. The age of the ovipositing female exerts an influence on the mortality of the ova. Similarly, susceptibility of the ova to insecticides was affected by the length of incubation period. A standardized testing methodology has been developed.

11P,11 SEXUAL STERILITY OF DERMATOBIA HOMINIS (LINNAEUS JR.) INDUCED BY CHEMOSTERILANTS. MOYA BORJA,G.E. (Universidade Federal Rural do Rio de Janeiro,Brazil)

The effect of four chemosterilants (Tepa, Thitepa, Hempa and Thiohempa) on the fertility of Dermatobia hominis, one of the most important pests of cattle in tropical areas of Latin America, was studied at the Universidade Federal Rural do Rio de Janeiro Brazil. Males and females of Dermatobia were successfully sterilized by immersing the pupae (26 days old) in 5 per cent Thiotepa, during 30 minutes. Similar results were achieved treating the adults (3-6 hr old) by tarsal contact with a residual film of Tepa and Thiotepa. Topical applications of these chemicals were not as effective as the immersion of pupae or tarsal contact treatments. Hempa was only partiallly effective as sexual sterilant. Flies from pupae treated with Thiohempa emerged with wing deformation and the longevity and sexual vigor were markedly reduced.(This study was supported by the National Research Council of Brazil.)

11P,12 THE ROLE OF HOUSE FLIES (MUSCA SPECIES) IN THE TRANSMISSION OF SOME HELMINTH PARASITES. Dipeolu, O.O.

Laboratory and field studies had been conducted into the ability of Musca to transmit through contamination helminth eggs and infective larvae. The maximum interval at which eggs and larvae can still survive after ingestion is given. The different roles of the crop and various sections of the intestine in these aspects are shown. Comparison is made of these capabilities with different Musca species in Nigeria.

11P,13 OVIPOSITION AND ECLOSION PATTERNS OF TICKS OF VETERINARY IMPORTANCE IN NIGERIA. Dipeolu, O.O.

The patterns of egg laying and their hatching and the factors affecting these were studied in several ticks of veterinary importance in Nigeria. The results are then related to the environmental conditions prevailing in Nigeria. The roles of temperature, state of engorgement and source of blood meal are highlighted.

11P,14

SEXUAL STERILITY OF *STOMOXYS CALCITRANS* (L.)INDUCED BY FEMALES OF *DERMATOBIA HOMINIS* (LINNAEUS JR.) TREATED WITH THIOTEPA. MOYA BORJA,G.E.(UNIVERSIDADE FEDERAL RURAL DO RIO DE JANEIRO, BRAZIL)

One of the most curious features of the life history of *Dermatobia hominis* is its oviposition behavior. When the females are ready to lay eggs, they seize other diurnal dipterans, often catching them mid-air. The vector insect is held closely under the thorax, using all six legs, while *Dermatobia* female attaches a mass of eggs. In this work, the possiblility that the vector females, *Stomoxys calcitrans* could be contaminated with Thiotepa at the moment of capture and oviposition by *Dermatobia* females, previously sterilized with Thiotepa, was studied. Based on the results obtained we can conclude that females of *Dermatobia* treated with Thiotepa by tarsal contact, can transfer the chemosterilant to the females of *Stomoxys* and induce partial sterility in this vector. (This study was supported by the National Research Council of Brazil.)

11P,15

The electrophysiological effects of direct application of DDT dissolved in organic solvents, on the ventral nerve cord of American cockroach. Giannotti, O., Holzhacker, E.L. (Instituto Biológico, São Paulo, Brasil - C.P. 7119).

Using the manitol-gap tecnique the treatment with petroleum ether (1) is not injurious to the central nerve cord of *P.americana*; in seven experiments, we observed only in one case a reduction of 40% in the external P.A.; the negative after-potential increased slightly, only in one case. D.D.T. (5 ug), applied in 1 of petroleum ether, caused some elevation in the negative after-potential.(3 preparations) and blocked the external P.A. from 23% to 40%; was observed some instability in the basic line of the polarization. From the 21 experiments, were the nerve was treated with hexana and acetone (7:3) in 4 was observed a slight elevation of the negative after-potential; in one case the nerve was 50% blocked and in 12 from 7 to 44%. D.D.T. (5 ug) applied in 1 of petroleum ether + acetone (7:3), in 32 experiments the negative after-potential was increased in 23; the external P.A. was completly blocked in 5 preparation, in 13 the P.A. was blocked from 50 to 77%, and in 9 from 17 to 44%; in the experiments where the central cord was not blocked, in 3 a recover was well characterized since the nerve was blocked in the first hour of the experiment returning at the normal conditions after ± 3 hs; the instability of the line of polarization was quite intense. These results show an evidence that D.D.T. is able to block the external P.A. of the central nerve cord of *P.americana* when in presence of a more polar solvent (20 - 30% of acetone in petroleum ether), interfering, probably, with the permeability of Na^+ through the membrane of the nerve.

11P,16

TYPES AND DISTRIBUTIONAL CHARACTERISTICS OF CULICINE MOSQUITOES IN ANAMBRA STATE NIGERIA.

Iwuala M.O.E. (National Arbovirus and Vectors Research Unit, P.O. Box 104, Enugu Nigeria).

There is limited information on the range of species and population ecology of culicine mosquitoes in parts of Nigeria and West Africa generally. Quite a few species of these insects have however been closely associated with outbreaks of yellow fever and other arbovirus infections in recent years, plus the continued maintenance and propagation of filariasis.

A survey of the culicine mosquitoes of Anambra State Nigeria was conducted between November, 1978 and December, 1979. Sampling was on weekly basis, employing sweep-net and crepuscular human bait collection methods. Mosquitoes were collected from all the 23 local government areas of the state and the results were pooled for assessment.

A total of 33 species of culicine mosquitoes, comprising 17 *Aedes* spp; 12 *Culex* spp, 2 *Coquilletidia* spp; 1 *Mansonia* sp; and 1 *Eretmapodites* sp. were recorded from the samples. The five dominant culicine species consisted of *Aedes aegypti*, *Ae. africanus*, *Ae. luteocephus*, *Culex perfuscus*, and *Cx. nebulosus*.

The *Aedes* spp. dominated in village crepuscular human bait collections, while *Culex* spp. dominated in the sweep-net samples. With a few exceptions, diurnal and monthly populations of the respective mosquito species showed considerable fluctuation during the year.

11W-1,1 METHODS EMPLOYED TO CONTROL THE HOUSEFLY PROBLEM IN CAMERON HIGHLANDS.

Inder Singh (Institute for Medical Research, Kuala Lumpur 02-14, Malaysia)

The housefly problem in Cameron Highlands has been known to exist since 1939. The greatest source of fly breeding are,

(i). the organic fertilizers viz. prawn dust, chicken droppings, pig dung, cow dung and soya bean cake which are extensively used in the vegetable farms and flower gardens.

(ii). vegetable debris left to rot in the vegetable fields after the vegetables have been harvested.

Attempts to control the fly problem using mainly insecticides in the towns and villages had been initiated from time to time. These campaigns though expensive were successful and provided limited control for a short duration.

Experiments conducted in the laboratory showed that prawn dust which had been composted for more than 4 weeks was unable to support larval development. Also, composted prawn dust was unattractive to female flies as an ovipositing media. Preliminary trials conducted in the highlands showed that prawn dust took 3-4 months for composting due to climatic factors.

11W-1,2 THE HOUSEFLY, *Musca domestica* L., INTRODUCED FROM ABROAD TO THE INTERNATIONAL AIRPORTS IN TOKYO.

Shinonaga, S., Y. Kusui and R. Kano (Dept. of Med. Zool., Tokyo Med. & Dent. Univ., 1-5 Yushima, Bunkyo-ku, Tokyo 113, Japan)

The housefly, *Musca domestica* L., is the most important species in genus *Musca* from the standpoint of public health. They find their habitats in garbage dumps, chicken farms, pig pens or garbage at market places in the tropics. They are endophilic in nature and are often carried by airplane from place to place. We investigated the houseflies introduced by aircraft from abroad into the international airports in Tokyo and have been able to correlate their origin with two morphological characteristics, i. e. frons/head width ratio and abdominal pigmentation as well as with susceptibility to different insecticides. Eight strains captured in Asian and Middle Eastern cities and 17 strains collected inside aircraft parking at the international airports in Tokyo were compared.

11W-1,3 The egg production and the larval development of *Musca domestica* in detail

Soebaktiningsih, (Dept. Par. & Ent., Fac. Med., Brawijaya Univ. Malang, Indonesia.)

The number of eggs laid by *Musca domestica* throughout the whole life were studied. When flies were kept in a group of 50 pairs of male and female, the number of eggs deposited by one fly throughout the whole life were 316. The eggs deposited by a group of flies were periodic with many peaks, because individual fly does not deposit eggs every day.

When flies were kept in a pair of male and female, the number of eggs deposited were 149. Individually once mated fly laid 927 eggs. Unmated fly laid 302 eggs and these eggs did not hatch.

Musca domestica laid eggs within 5 days, egg hatched to larvae within one day, larvae develop to pupae within 5 days. The first and the second stage larvae required one day for development in each stage. Pupae become adult within 3 days.

11W-1,4 MYIASIS IN DOMESTICATED ANIMALS IN THE FOOTHILLS OF DARJEELING AND NEIGHBOURING AREAS.

Roy, P. and Dasgupta, B. (Zool. Dept., Siliguri Coll., Siliguri 734401, India.)

The authors describe~~s~~ the result of a survey conducted in Siliguri and adjoining areas. The study revealed that Chrysomya bezziana is the most dangerous myiasis producing fly in the area followed by Sarcophaga misera and Sarcophaga ruficornis. Most commonly infested animals are cow, pig, sheep, buffalo, horse, camel, donkey, goat and fowl. Chrysomya megacephala and Calliphora vicina are also found to cause myiasis in association with C. bezziana.

11W-1,5 ISOLATION OF VIRUSES FROM SYNANTHROPIC FLIES COLLECTED IN W. AFRICA.

Kurahashi, H., Kono, R.,*Minami, K., Yamazaki, S. and Sasagawa, A. (National Institute of Health , Tokyo 141 and*Fukushima Medical College, Fukushima 960)

In connection with the exploration of the origin and the epidemiology of acute haemorrhagic conjunctivitis (AHC) virus (August to October 1977), a large number of synanthropic flies were collected and processed for viral isolation in Ghana and Senegal, W. Africa. We considered that the AHC virus might have originated from an insect picornavirus and synanthropic flies or other insects with a habit to have access to human eyes might transmit it to humans as a carrier or vector. We examined 107 pools of the following insect material: Musca domestica complex, M. sorbens, M. tempestatum, Chrysomya marginalis, Ch. putoria, Hemipyrellia spp., Lucilia cuprina, L. sericata, Sarcophaga spp., Stomoxys sp., and other flies and sweat bees. Human enteroviruses were isolated from 45 pools of these materials. Twenty-four pools were identified as follows: Poliovirus type 3 (1), Echo type 1 (2), Echo type 7 (13), Echo type 12 (4), Echo type 20 (1), Echo type 21 (2) and Echo type 29 (1). However, we could not detect the AHC virus from these materials.

11W-1,6 ESTABLISHING THE TIME OF DEATH USING THE LARVAE OF FLIES IN HUMAN CORPSES

Kano, R., Shinonaga, S., Nishida, K. and T. Nagata (Dept. Med. Zool., Tokyo Med. & Dent. Univ., 1-5 Yushima, Bunkyo-ku, Tokyo 113, Japan)

There are numerous forensic-medical methods for estimating the time of death of abandoned human corpses. Of cadaverseeking insects, the larvae of flies which feed on copses had been measured since a long time ago in order to establish the time of death. However, in such a method estimation was made only on the basis of the size of the larvae of flies. No concern was given to the kinds of flies or to the speed and extent of their growth, requisites for sure evaluation. If the species of flies, their body weight and length at each temperature and average ambient temperature are known, such an estimation becomes more reliable. We raised 10 important species of calliphorid and sarcophagid flies at five temperature stages ranging from 15 to 35°C at 5°C increments in order to study the speed of growth of each species, fundamental data for estimation of the time of death. Comparison of these data was made with the flies collected from 24 cadavers. Feasibility of this method is discussed.

11W-1,7 DIPTERA IN DUNG AND CARRION: ECOLOGICAL ASPECTS. Beaver, R.A. (Dept.Biol., Univ. Zambia, Lusaka, Zambia)

A number of Muscoid Diptera of medical and veterinary importance breed in nature in dung or carrion, where their larvae are an important element of complex short-lived communities. Dung and carrion form small, scattered habitat 'islands' in a spatially and temporally shifting pattern, which must be tracked by the adult flies. The adults are opportunistic colonists and strongly selected for their dispersive and habitat-finding abilities (r-selection). The larvae live in a nutritious medium which is sought out by many species leading to both diversity and crowding of the inhabitants. Competition between larvae is frequently intense (K-selection). The life history strategies of the flies are discussed in relation to their size and dispersive ability, and to the compromises required due to differing selection pressures on adults and larvae.

Coexistence of these competing species can be helped by seasonal and successional differences in resource utilisation, and by selection of carrion or dung of different species. The necessary conditions for breeding site specialisation are discussed, and found to be frequently lacking in nature. Because colonisation is only possible over a short period, the chance arrival of particular species before others, short-term meteorological events, and changes in the habitat itself affect the composition of the colonising community, and may permit more species to coexist.

Man's provision of larger and more regularly renewed breeding places, e.g. manure piles, rubbish dumps, improves the survivorship of the flies by tending to reduce both the difficulty of finding breeding sites, and larval competition. The natural ability of the flies to locate and breed in small scattered habitats makes control measures more difficult.

11W-1,8 VERTICAL DISTRIBUTION OF CALLIPHORID FLIES AND ITS SEASONAL CHANGE IN JAPAN NORTHERN ALPS. M. Watanabe, M. Arai (Toyama Institute of Health, Toyama 930) and Kamimura,K. (Toyama Med.Phar.Univ.,Toyama 930-01)

Observations were made on the vertical distribution of calliphorid flies, from 1975 to 1979, in Mt.Tateyama area, Japan Northern Alps, except snow seasons.

Approximately 34000 calliphorid flies collected in the fly traps were examined. They belonged to 7 species among which approximately 95% were classified into *C. lata, C. vomitoria, A. grahami* and *T. calliphoroides*. These 4 species, appearing immediately before snow melting, distributed at the low-altitude area in both spring and autumn, while in summer they were found only at the high-altitude area of 2000m or high.

11W-1,9 BIOLOGY OF PERUVIAN BLOW FLIES. Greenberg, Bernard (Dept. Biol. Sciences, Univ. Illinois at Chicago Circle, Chicago, Illinois 60680, U. S. A.)

A program for the study of Peruvian blow fly biology is described. It includes bionomics and descriptions of developmental stages of hitherto undescribed life cycles, distributions, and synanthropy of coastal sierran, and jungles species. The discussion centers on Sarconesia, Paralucilia, and Calliphora species of the sierra.

11W-1,10 RECENT KNOWLEDGE ON THE BIOLOGY OF THE HORN FLY, (*HAEMATOBIA IRRITANS*) IN JAPAN.

Hasegawa, T. (Tohoku Nat.Agr.Exp.Sta., Morioka, 020-01 Japan)

The horn fly, *Haematobia irritans* (Stomoxyinae, Diptera) is a well known blood sucking insect attacking live-stock and it has a wide distribution range in the world. The time of introduction of the horn fly to Japan is unknown. In 1916, Dr. H.Kobayashi discovered the horn fly in Okayama district, southern Honshu, and identified it as *Lyperosia* sp. This seems to be the first record on the occurrence of the horn fly in Japan. Up to the present, occurrence of the species have been recorded extend over almost the whole area of this country, and its infestation to the grazing cattle shows a increasing tendensy. Since 1970, I have been studying on the biology and control method of the horn fly in Japan. Although, our study is still in continue, I will introduce in this work shop the present state of our knowledge on the biology of the horn fly in Japan mainly based on our works.

11W-1,11 ON THE CALLIPHORID, SARCOPHAGID AND MUSCID FLIES (DIPTERA) IN KOREA.

Park, S. H. (Dept. Biol., College of Education, Gyeongbuk Univ.,
Daegu, South Korea)

The study of flies in Korea was first made by Kobayashi. He studies their growth pattern and bionomics, reproduction, overwintering, seasonal prevalence and egg-laying the period from 1919 through 1945. During the period from 1943 to 1945, Hori collected flies in vicinity of Seoul and Suwon. He added 25 species unreported in Korea thus far to the 16 ones reported previosly by Kobayashi. He was actually the first of the taxonomical report on the flies in Korea. It was not until 1959 that the studies on the flies were resumed in Korea after World War II. Then the author began taxonomical and ecological studies initiated by his predecessors, particularly Kobayashi and Hori.

A total of 100 species reported in Korea since 1919 is described which consists of the collections by Kobayashi, Hori and author. They include 20 species belonging to 13 genera of the Calliphoridae, 38 species belonging to 15 genera of the Sarcophagidae and 42 species belonging to 14 genera of the Muscidae. The author found newly 59 species of Calliphorid, Sarcophagid and Muscid flies including 4 new species.

11W-1,12 THE CALLIPHORIDAE AND SARCOPHAGIDAE: A REAPPRAISAL.

Brown, K.R. (Sch.Biol. Sci.,
Univ.Sydney, 2006 Australia.

Two important elements of the Australian Diptera, families Calliphoridae and Sarcophagidae, were examined. In this study 137 OTUs corresponding to both named and unnamed taxa in the ANIC were analysed. Existing classifications were shown to have several drawbacks. Undue reliance has been placed on characters which are ideal for identifying taxa but do not satisfactorily group i.e. classify taxa. It is suggested that characters should be quantified and the variability assessed within- and between-taxa. A morphometric assessment of the families is reported using multivariate methods. Canonical variate analysis and the generalized distance statistic are useful ways of examining such data. The canonical group means were assessed by considering the minimum spanning network superimposed upon the three-dimensional ordination diagrams and by cluster analysis. It was shown that such phenetic relationships can be used to confirm and/or add to the already existing phylogenetic scheme. Work is continuing with the appraisal of genetic (biochemical) characters with respect to morphometric characters and the resulting taxonomy of these taxa.

11W-1,13 CHLOROPIDAE OF MEDICAL AND VETERINARY IMPORTANCE.

Sabrosky, C.W.(Systematic Ent. Lab., U. S. Dept. Agriculture, Washington, D. C., U. S. A.)

Most chloropid flies are plant pests or scavengers, but some, though tiny, can occur in large numbers and can be exceedingly annoying as well as mechanically transmitting causative organisms of some diseases. The major chloropid pests of this type are "Hippelates flies" of the Western Hemisphere and Siphunculina spp. in the Orient. Minor nuisances are Oscinella aharonii ("Oscinis pallipes") of Egypt and Thaumatomyia spp. that occasionally swarm in houses in Europe and North America.

Hippelates flies are discussed in detail. Old World "Hippelates" belong to the genus Cadrema and are not pests. New World species have recently been revised and divided into Hippelates s. str. (solitary eye gnats), with about 28 described species, and Liohippelates (swarming eye gnats and yaws flies), with about 27 described species. Non-pest species previously included in Hipperates have been placed in a new genus, Apallates.

Liohippelates, which includes the real pest species, has been shown to breed chiefly in humus, the organic matter in soil, especially in light, sandy soils. True Hippelates species have been found as leaf miners in genera of the lily and amaryllis families. Apallates species breed in a variety of decaying organic matter.

Hippelates and Liohippelates species are attracted to all body orifices, notably to eyes and genitalia, and thus may transmit bacilli and other causative organisms of epidemic conjunctivitis, yaws, bovine mastitis, etc.

11W-1,14 MYIASIS OF NEWBORN CALVE IN HAWAII.

Hardy, D. Elmo (Dept. of Ent., Univ. of Hawaii)

A peculiar type of myiasis occurs in certain regions of Hawaii which has not been reported elsewhere. This involves the blow fly Chrysomyia rufifacies (Macquart), a species which is widespread over much of Asia and the Pacific. In other areas this species is recorded as a predator on other blow flies, especially C. megacephala (Fabricius). On ranches in areas of high rainfall in the Hawaiian Islands, the newborn calves are frequently "struck" by the flies and the maggots feed on living tissue. They cause a peculiar type of parasitism, attacking only the dermis and connective tissues and literally eating the skin off large sections of the body of the young animal. Approximately 10% of the newborn calves are parasitized in some areas and unless the parasitism is detected and the calves promptly treated, the animals dies within seven days after birth.

Section 12.

Biological Control.

12S-1,1 THE ROLE OF INTRODUCED AND NATIVE PREDACIOUS MITES IN BIOLOGICAL CONTROL OF SPIDER MITES IN JAPAN. Mori, H. (Inst. Applied Zoology, Hokkaido Univ., Sapporo, 060 Japan)

Biological studies on native phytoseiid mites and predator-prey interactions between phytoseiids and tetranychids revealed that Amblyseius longispinosus Evans and Amblyseius deleoni Muma et Denmark are potential biological control agents of tetranychid mites. The fundamental and practical studies were carried out to determine the feasibility of utilizing an introduced predator Phytoseiulus persimilis Athias-Henriot for the control of the spider mite populations on several agro-ecosystems in Japan. The combined action of P. persimilis and A. longispinosus resulted in an effective suppression of tetranychid populations in the experimental system.

The characteristics of the native habitats of phytoseiids and their predacious efficiencies will be discussed.

12S-1,2 BIOLOGICAL CONTROL OF TRIALEURODES VAPORARIORUM BY ENCARSIA FORMOSA, SUCCESSES AND DISAPPOINTMENTS. Lenteren, J.C. van and Woets, J. (Dept. Ecology, Leiden University, the Netherlands)

Since 1926 the parasitic wasp *Encarsia formosa* Gahan (Hym.: Aphelinidae) has been used successfully in many countries to control the greenhouse whitefly *Trialeurodes vaporariorum* (Westwood) (Hom.: Aleyrodidae). The first large-scale use of this parasite in the Netherlands started in 1972. Biological control of the greenhouse whitefly was very successful in tomato crops, but control often failed in cucumber crops. Detailed research on the relation between host plant, phytophagous insect and parasitic insect showed that the population development of whitefly on cucumber was much faster than on tomato. Further, the leaf structure of those two plants differs considerably: the large hairs on cucumber hamper the wasp in searching for hosts. The Institute for Horticultural Plant Breeding (Wageningen) used a Russian cucumber mutant without hairs to breed new, hairless varieties. Results of glasshouse experiments with these hairless varieties show that parasitism is about 20% higher than on the usual varieties.
If 'smooth' leaves alone do not sufficiently increase the parasitization efficiency to obtain reliable control, it will be necessary to check whether there are cucumber varieties that are (partly) resistant to whitefly.
For a review of the biological control situation in Dutch glasshouses see: J.C. van Lenteren *et al.*, 1980. Integrated control of vegetable pests in glasshouses. In: Integrated control of pests in the Netherlands (P. Gruys & A.K. Minks, eds.). Pudoc, Wageningen, 300 p.

12S-1,3 Biological Control of Citrus Snow Scale in Florida, Brooks, R.F. Univ. of Florida AREC Lake Alfred, Florida 33850 USA

Citrus snow scale, Unaspis citri (Comst.), had developed into a major pest of Florida citrus by 1970 (Brooks, 1973). Chemical control required 2 high volume applications of phosphatic insecticide per year just to live with this pest. In 1972 the parasite, Aphytis lingnanensis Compere (HK-1), was introduced from Hong Kong as part of the U.S. National Science Foundation's Integrated Pest Management Program. Initial releases were immediately successful in the severely infested citrus groves of central Florida. Today, this parasite is keeping citrus snow scale populations below damaging levels in most of Florida's 336,000 hectares of citrus.

12S-1,4 Establishment of a Lady Beetle to Control Date Scale in the Southern Sahara. Stansly, P., Kaufman, T. (Dept. of Ent., Texas A&M Univ., College Station, TX 77843 U.S.A.)

Chilocorus bipustulatus L. from Iran was introduced into date palms to control the armored scale Parlatoria blanchardi Targ. in the Sahara of Niger. Within 4 years the new predator spread and established throughout the zone. Conditions proved most favorable for the ladybeetle during the short summer rainy season when new sites were rapidly colonized causing significant reduction of diaspidid infestations. Prey scarcity then limited predator populations and young adults dispersed. At other seasons, harsh climatic conditions effected the beetles adversly in exposed situations but natural shelters permitted year-round reproduction. This suggested the planting of refuge areas in the center of groves near water sources consisting of closely spaced date trees surrounded by live wind-break. The low cost technology of this successful project is the type especially applicable to developing countries.

12S-1,5 BIOLOGICAL CONTROL OF SUGARCANE BORER IN LATIN AMERICA AND THE WEST INDIES

Bennett, F.D. (Commonwealth Institute of Biological Control, Gordon St., Curepe, Trinidad)

Biological control of sugarcane borer Diatraea spp. has been attempted in several countries in Latin America and the West Indies by extending the distribution of the neotropical Tachinids Lixophaga diatraeae, Metagonistylum minense and Paratheresia claripalpis, by the introduction of the old world Braconid Apanteles flavipes, by inoculative and inundative releases of these parasites and/or by inundative releases of Trichogramma spp. Where possible cost benefit data are given. These indicate an annual reduction in sugar losses valued at several million dollars.

12S-1,6 BIOLOGICAL CONTROL OF OSTRINIA NUBILALIS BY TRICHOGRAMMA MAIDIS IN FRANCE.

Voegelé, J., Miermont, Y., Stengel, M., Anglade, P., Hawlitsky, N. (Zoologie et lutte biologique, INRA, 06 602 Antibes France)

The parameters for the success of biological control of Ostrinia nubilalis are investigated. They are chiefly the right choice of the best adapted Trichogramma strain, its precise determination, its mass rearing on a performant host, the preservation of its biological potentialities all along the production and transport, the mastery of process of genetic drift, the best kind of presentation and formulation at the time of its distribution in the field, the strategy who considers the spatio-temporel coincidence with the host and limits the number of releases.

12S-1,7

BIOLOGICAL CONTROL OF PADDY WEEDS BY THE TADPOLE SHRIMPS (BRANCHIOPODA:TRIOPSIDAE) IN JAPAN.

Katayama, H. (Tadpole Shrimp Res. Center, Kyodo Sci. Agr. Res. Lab., Suita,
Osaka 564, Japan) and Takahasi, F. (Fac. Integ. Arts & Sci., Hiroshima Univ.,
Hiroshima 730, Japan)

The species of genus Triops are four, and three out of them, such as Triops cancriformis cancriformis, T. longicaudatus longicaudatus and T. granarius are distributed in Japan. They are fundamentary detritus and filter feeders, so the effectiveness of controlling the seedlings of weeds in rice fields comes from mainly physical mechanism. For that reason the shrimps can control various kinds of the seedlings of weeds at the same time. The shrimps make the water muddy in the fields by diging up the surface of soil. The photsynthesis of the seedlings of weeds are disturbed by the muddy water, which is called as "biological mulch". However their injurious effect on rice seedlings are avoided through the transplanting process commonly practiced in Japan. The effectiveness of weeding has been noticed by farmers through their experiensis and at present they are undertaking the practice by their executive association in some local districts. A monoculture system has been recentry reinforced in Japanese rice fields and resulted in the simple food chain relation reducting the activity of natural enemies. This makes the aquatic environment in rice fields favorable for the population of the tadpole shrimps.

12S-2,8

PRINCIPLES OF INTRODUCTION AND ESTABLISHMENT AS ILLUSTRATED BY SUCCESSFUL BIOLOGICAL CONTROL OF WOOLLY WHITEFLY, ALEUROTHRIXUS FLOCCOSUS (MASKELL), IN CALIFORNIA. DeBach, P. (Div. Biol. Cont., Univ. of Calif., Riverside, CA 92521 USA)

Normal introduction procedures of rearing at least one generation of the imported parasites in quarantine had to be modified because no quarantine-rearing facility existed in the invaded area (San Diego). Therefore, parasitized material was imported to the Riverside quarantine facility, adult parasites reared and authenticated as being primary parasites and then immediately released directly in the field. Since mass culture for field release and distribution was precluded, heavily infested "insectary-trees" were used to mass produce parasites in the field. Small inoculations yielded very large returns. Transfer of parasitized pupae on leaves from "insectary-trees" were used to hasten natural dispersal and to establish parasites in new areas. The method proved more economical and effective than the usual insectary production techniques.

Purposeful multiple importation of various species of parasites from different countries resulted in 3 species being initially established. Thereafter, interspecific competition eliminated one species but with no ill effect on degree of biological control achieved. Cales noacki Howard and Amitus spiniferus Hempel now jointly control the woolly whitefly. They coexist because they are not ecological homologues.

12S-2,9

REPRODUCTION OF VEDALIA AND OTHER USEFUL COCCINELLIDS ON ARTIFICIAL DIETS.

Niijima, K. and Matsuka, M. (Fac. Agr., Tamagawa Univ., Machida-shi, Tokyo 194 Japan)

Drone honey bee brood has been known to be a surperior diet for many insectivorous coccinellids. Several aphidophagous beetles such as *Harmonia axyridis, Menochilus sexmaculatus, Eocaria muiri* etc. have reproduced through successive generations on the drone powder (DP) and water only. A typical Eurasian species, *Coccinella septempunctata (bruckii)* can be added to the list as having been reared 4 generations. Other aphidophagous coccinellids such as *Adalia bipunctata* and *Hippodamia convergens* were also reared on the diet but did not recycle successively because adults did not oviposit or larvae did not grow well. Coccinellids with different food habits reproduced with the drone powder to different extents: *Aiolocaria hexaspilota* (chrysomelid larva feeding) 4 generations; *Anisocalvia 14-guttata* (jumping plant-lice) 2; *Chilocorus kuwanae* (coccids) 2; and *Illeis koebelei* (fungus) 2.

Dietary properties were improved by mixing sucrose (30-50%) with DP to accommodate Vedalia beetles, *Rodolia cardinalis* which did not eat the original drone powder. The beetles survived 75 days and laid 104 eggs with the sugar mixed diet (DPS), which were 218% and 21%, respectively, of those fed with *Icerya*. When absorbent cotton was supplied as ovipositional substrate, total number of eggs laid was increased and the capability of recovering the eggs was improved. Two combinations of DPS and *Icerya* feeding (*Icerya* fed every third day or on the first three days only) increased the efficiency of egg production per unit amont of *Icerya* consumed 10-20 times as much as the original *Icerya* feeding method. However larval growth of Vedalia was poor on artificial diets.

12S-2,10 THE BIOLOGICAL CONTROL OF BOVINE DUNG IN AUSTRALIA. Waterhouse, D.F. (CSIRO Div. of Ent. Canberra, Australia).

The introduction of cattle into Australia in 1788 with the first European settlers has upset the ecological balance for nearly two hundred years. With few exceptions native Australian dung beetles do not bury or disperse the 10 or so large dung pads produced each day by each bovine. This results in large accumulations of dung which smother valuable pasture and serve as breeding grounds for nusiance flies. A program for introducing bovine dung beetles from Africa and other countries is already giving very valuable results as well as some interesting and unexpected facts. Current progress will be reviewed.

12S-2,11 THE LOGISTICS OF A SUCCESSFUL BIOLOGICAL CONTROL PROGRAM. HART, W.G. (Citrus Insects Research, USDA-SEA-AR, Weslaco, Texas USA).

Two successful biological control programs were recently undertaken against the citrus blackfly, Aleurocanthus woglumi, in two distinct citrus areas of the U.S. Different approaches were used against two newly introduced infestations of this serious pest of citrus. In one program both field collected and laboratory reared parasites were introduced. In the second program all releases were from vigorous laboratory reared stock. Variations in results are discussed.

12S-2,12 INTRODUCTION OF PARASITES AGAINST MEDITERRANEAN BLACK SCALE SAISSETIA OLEAE (OLIVIER) IN ISRAEL AND THE PROBLEM OF ENCAPSULATION IN ALTERNATIVE HOSTS. Blumberg, D. and Swirski, E. (Div. Ent., A.R.O. Volcani Center, Bet Dagan, Israel)

Nine African species of hymenopterous parasites were introduced into Israel by the Agricultural Research Organization during 1972-1978, for the control of the Mediterranean black scale Saissetia oleae (Olivier) in citrus groves. The pteromalid Scutellista aff. cyanea Motschulski and the encyrtids Metaphycus bartletti Annecke & Mynhardt and M. lounsburyi (Howard)became established; M. bartletti proved the most abundant.

The mass rearing of M. swirskii Annecke & Mynhardt on the hemispherical scale Saissetia coffeae (Walker) and on the brown soft scale Coccus hesperidum was difficult because many of the eggs were encapsulated. Egg encapsulation by these two coccids became more frequent as the host matured.

Exposing the host to extreme temperatures (low or high) prior to parasitization reduced the encapsulation incidence by both the hemispherical and the brown soft scale. This procedure improved the mass rearing of M. swirskii.

12S-3,14 THE USE OF BIOTIC AGENTS TO STRESS NOXIOUS WEEDS. P. E., Boldt (Biol.Control Lab., USDA, U.S.Embassy, Rome, Italy)

Individual species of biological control agents may not by themselves be able to reduce populations of a noxious weed. However, by the selection of several agents which attack different plant parts and at different times of the growing season, the resulting stress could reduce the plant's vigor and it reproductive potential. Examples from current research on noxious thistles are discussed.

12S-3,15 INSECT FEEDING EFFECTS ON HOST PLANT TISSUES, PHYSIOLOGY AND SURVIVAL; THE IMPACT OF COLEOPHORA PARTHENICA MEYRICK ON SALSOLA IBERICA SENNEN ET PAU. Pemberton, R. and Andres, L. (United States Department of Agriculture, SEA/AR, Albany, CA 94706, USA)

The success or failure of a biological control of weeds project hinges upon the amount of stress imposed upon the target plant by its natural enemies in conjunction with other environmental factors. The ability of a natural enemy to control its host depends largely upon which tissues are damaged, the degree of impairment in the function of these tissues in relation to their role in the plant's development, persistence and reproduction. The impact of the feeding damage caused by Coleophora parthenica Meyrick, a coleophorid stem-boring moth, upon its host Salsola iberica Sennen et Pau, a naturalized weed in California, is discussed.

12S-3,16 EVALUATION OF DAMAGE CAUSED BY GASTROPHYSA ATROCYANEA MOTS.(COL.: CHRYSOMELIDAE) TO RUMEX OBTUSIFOLIUS L. Miyazaki,M. and Naito,A.(Ent. Lab., Nat. Grassl. Res. Inst., Nishinasuno, Tochigi, Japan)

Growth of R. obtusifolius is greatly affected by feeding of G. atrocyanea. The influence of the beetle on the dock's vigor was found to be more prominent than that of defoliation by clipping. The controling effect of the beetle on the weed was much pronounced when docks growed competing with grass.

12S-3,17 EXPLOITATION OF ALIEN WEEDS BY INDIGENOUS PHYTOPHAGOUS INSECTS. Goeden, R. D. (Div. Biol. Control, Dept. Ent., Univ. of California, Riverside 92521 U.S.A.)

Within a few decades after their initial colonization, most well established, herbaceous, alien weeds host a substantial number of indigenous phytophagous insect species. More species feed than reproduce on these newly colonized plants. The insect fauna of such weeds largely consists of polyphagous, ectophagous, sap- and foliage-feeding species, and may include several economic pests. Consequently, little use has and probably can be made of indigenous phytophagous insects through augmentation or conservation in the biological control of alien weeds. Nevertheless, faunistic surveys of alien weeds remain essential preliminary phases of biological weed control programs. These surveys also find contemporary use in characterizing the biogeographic dynamics of insect/host-plant communities.

12S-3,18 SELECTION OF INSECT BIOTYPES AS AGENTS FOR THE BIOLOGICAL CONTROL OF WEEDS.

Harley, K.L.S. and Sands, D.P.A. (CSIRO Div. of Entomology, Indooroopilly, 4068. Q. Australia)

In programmes for the biological control of weeds, greater success may result from the comparative study of geographical variants or biotypes of potential insect agents. Biotypes should be selected for suitability to: (i) the genetic variety of the weed (ii) the climate of the region where the weed problem exists and (iii) the phenotypic plasticity of the weed. Insect biotypes can be distinguished by comparing the reactions of populations to short and long-term temperature stress, temperature threshholds for the development of immature stages, the effects of variation in temperature and humidity on mortality, reproduction and adult feeding, and their food utilisation and bioenergetics. Morphological and electrophoretic studies may provide useful genetic markers for distinguishing biotypes and for studying their dispersal.

12S-3,19 THE PARTITIONING OF ASSIMILATES WITHIN PLANTS AND ITS IMPORTANCE TO THE BIOLOGICAL CONTROL OF WEEDS. Room, P.M. (Ent. Division, CSIRO, Brisbane, Australia).

An individual plant is a dynamic system which is continuously changing. The constant genotype interacts with the changing environment and changing phenotype to create new phenotypes by altering the way assimilates are partitioned between different functions. Insects which disrupt partitioning should be efficient weed control agents.

Weeds adapted to stable habitats invest more heavily in structure (size) and defense (longevity) while weeds adapted to less stable habitats invest more heavily in reproduction and dormancy. Populations of the former weeds might be more sensitive to seed predation and populations of the latter to plant parasites.

Most weeds are very plastic, being able to adopt different phenotypes through inter and intra genotype variation in partitioning. Many attributes of plants important to natural enemies are plastic. Implications include the need to consider phenotypes in addition to genotypes when searching for potential control agents and when testing host-specificity.

12R-1,1 Role of Natural Enemies in Regulation of Coccids and Aleyrodids Number on Citrus Crops in USSR.

Yasnosh V.A. Research Institute of Plant Protection. Tbilisi.

Citrus plants are attacked by 2I species of coccids and I-of aleyrodids. 2I speciea of parasitic Hymenoptera (Aphelinidae, Encyrtidae, Signiphoridae) and about 20 species of predators (Coccinellidae and other) are known on these pests. From these natural enemies 5- were successfuly imported for biological control but 8- were distributed themselves together with their hosts. Complete or partial success in biological control have accounted for I4 species of pests (Coccoidea: Monophlebidae-I, Pseudococcidae-2, Coccidae-4, Diaspididae-6; Aleyrodidae-I). Three species of coccids: Ceroplastes japonicus Green, C. floridensis DelGuer., Lopholeucaspis japonica Ckll. without of any specific parasites in our fauna. They appear the most important group of citrus pests. To this group belongs also Dialeurodes citri Ashm. However during last two years dicrease of its populations and economic damage was observed.

It is real possibility for protection the citrus crops without insecticidal treatment by additional introduction and acclimatisation of some entomophagous insects.

12R-1,2 NATIVE PARASITES OF THE GREENHOUSE WHITEFLY, *TRIALEURODES VAPORARIORUM* (WESTWOOD) IN JAPAN AND THEIR PRELIMINARY RELEASE.

Kajita, H. (Fac. Agr.,Kyushu Univ., Fukuoka, 812 Japan)

Six species of hymenopterous parasites have emerged from the greenhouse whitefly collected in Japan during 1975-78. *Encarsia* sp.A and *Prospaltella* sp. were relatively common species, whereas *Encarsia* sp.B, *Eretmocerus haldemani* Howard,*Eretmocerus* sp. and *Prospaltella lutea* Masi were rare ones. Although *Prospaltella* sp. was the most dominant species, the number of hosts attacked by an adult parasite was significantly less than by that of *Encarsia* sp.A. The ability of these native parasites in controlling the whitefly population was examined, but it was concluded that they were inferior to the introduced *Encarsia formosa* Gahan.

12R-1,3 FIELD EVALUATION OF THE EFFECTS OF INTRODUCED NATURAL ENEMIES ON THE POPULATION DYNAMICS OF *PIERIS RAPAE* IN OKINAWA.

Itô, Y. (Lab. Appl. Ent. & Nematol., Nagoya Univ., Nagoya,464 Japan)

Pieris rapae was accidentally introduced into Okinawa in later 1950's and became a serious pest of cabbages. The population density falls every summer to a very low level and rises through autumn, winter and early spring. Life table studies showed that the decrease in summer is mainly due to high mortality of eggs and the 1st instar larvae in late spring. It was found that shortage of *Apanteles glomeratus*, larval parasite, and lack of the granulosis virus and *Pteromarus puparum*, a pupal parasite, are the major reason which allows this species to propagate during autumn and winter. Introduction of *A. glomeratus* and the granulosis virus could suppress the rate of adult emergence to a level where the rate of population change became negative in winter and spring, but both the natural enemies extincted during summer due to shortage of the host. Release of the granulosis virus in every autumn may be one of the methods to decrease the amount of insecticides used to control *Pieris rapae* in Okinawa.

12R-1,4

INVESTIGATIONS ON THE INTERACTION and BIO-ECOLOGICAL RELATIONSHIP OF NATURALLY OCCURING ENEMIES OF *LYMENTRIA OBFUSCATA* (LEPID:LYMENTRIIDAE)

Rishi. N.D. (P.G. Deptt: University of Kashmir Srinagar 190006
India)

Anastatus kashmirensis, *Brachymeria intermedia* *Dibrachys cavus*, *Exorista rossica*, *Megaselia parasitica* and *Hoplectis altermans* were identified effective parasitoids and Predators at egg prepupae and pupae of *Lymentria obfuscata* in Kashmir. They are the most dominating and widely distributed and show ability to occupy and survive at OC° t0 -5°C at all host inhabited niches. Their population in the natural enviorment is subjected to low temperature -12C° and frost but they show stability in life-cycle and biology which synchronize with the host and the environment.

12R-2,5

PYRRHOPYGE PELOTA PLOTZ (LEP. HESPERIIDAE): MORPHOLOGICAL STUDY ON THE INMATURE STAGES.

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INTA Castelar,República Argentina.

P.pelota was recorded for Argentina on *Psidium guajaba* L. in Corrientes, Chaco, Formosa (Hayward 1948); on *Eucalyptus* sp in Bella Vista,Corrientes (Center)(Crouzel 1966).In 1977 it began to be dangerous on the *Eucalyptus grandis* Hill forests in Ituzaingó, Corrientes (NO).

The bioecological research carried out intends a biological method to control this species. Studies were done on the biological cycle, behaviour, population dynamic, natural enemies.

This part of the work concerns the morphology of the inmature stages. It is not the purpose of the paper to describe the species but mainly to determine the number of instar larvae and to know different characters which allow to recognize each instar in an easy and practical way to permit the setting up of relations between instars and its respective natural enemies.

Apparently the species has 3 generations per year : fall-winter with 7 instar larvae,summer with 6 and spring with possible 6.

Chosen characters - Head: colour,sculptures, round plates and setae (type and colour).
Torax-abdomen: yellow bands, hairs rows, relation between spiracles and a pigmented plate associated to them in the 1°and 2°segments of the abdomen.

12R-2,6

ON THE BIOLOGY AND MORPHOLOGY OF THE EGG-LARVAL PARASITE, *CHELONUS BLACKBURNI* CAM. (HYM.,BRACONIDAE).

KASCHEF.A.H., Entomology Dept.,Faculty of Science,AinShams Uni,,Cairo,
R.A.EGYPT.

The life history of the parasite,*Chelonus blackburni* Cam.(Hym.,Bracnidae) has been studied at constant conditions of temperature and relative humidity.

1. At 18, 27 &35°C.+ 1°C. and 65+5% R.H. the mean duration of the life cycle was 64.02± 5.9 days, 29.1 ±1.9 days and 19.4 ±1.6 days respectively.
2. The average number of adult *C.blackburni* which emerged from a single larva of *Heliothis armigera* at 26 ±1°C. and 65±5% R.H. was only one.
3. The mean fecundity of the female parasite at 26 ±1°C. was 612 .6 eggs and the mean number of eggs laid per female was 54.5 eggs.
4. The number of host eggs parasitised by one parasite female in the lboratory under room conditions during 24 hours averaged 36.5 eggs.
5. The female of *C. blackburni* reproduce parthenogenitically and the nonfertilised eggs give rise to females.
6. A brief description of the morphology of the developmental stages of the parasite *C. blackburni* CAM. has also been given.

12R-2,7 ABILITY OF A GREGARIOUS PARASITOID, EUPLECTRUS KUWANAE CRAWFORD IN DISCRIMINATING THE HOST SIZE.

Uematsu, H. (Fac. Agr., Kyushu Univ., Fukuoka, 812 Japan)

Euplectrus kuwanae is known as a gregarious ecto-parasitoid of some lepidopterous larvae. The female of the parasitoid deposits egg-masses composed of 3 to 30 eggs on the abdominal segment of the host. The oviposition experiments of the parasitoid were conducted by using larvae of Argyrogramma albostriata as a host under laboratory conditions. Size of the egg-mass was increased linearly as the host weight increased. The sex ratio (female/ female + male) was between 0 and 0.2 when the host less than 10 mg, whereas it was between 0.6 and 1.0 when the host was larger than 50 mg. When the host size was intermediate it was considerably fluctuated. These results suggest that the females of the parasitoid would be possible to discriminate the host size, and tend to oviposit diploid eggs (female) on larger host and haploid eggs (male) on smaller one.

12R-2,8 UNUSUAL ATTRIBUTES OF THE COCHINEAL INSECTS (DACTYLOPIIDAE) AND THEIR RÔLE IN THE BIOLOGICAL CONTROL OF OPUNTIA WEEDS.

Moran, V.C., and Annecke D.P. (Dept.Ent., Rhodes Univ., Grahamstown 6140 and Plant Prot.Res.Inst., Pretoria 0001, South Africa.)

Some aspects of the biology of the cochineal insects are briefly discussed as follows:

(i) the systematic position of this circumscribed but difficult group;

(ii) their interesting life histories which have only very recently been illucidated; this in spite of the fact that the Dactylopiidae have been known for centuries as a source of carmine dye, and were the first organisms used intentionally for the biological control of weeds;

(iii) the unusual position of the cochineal insects among the phytophagous community on opuntias, and their apparently unique status as a group of insects which are completely free of parasitoids;

(iv) the disproportionate importance of this small group of insects in Opuntia control programmes world-wide; and

(v) the novel methods that have been used to augment the action of cochineal insects in biological control.

12R-3,9 A SUMMARY OF CLASSICAL BIOLOGICAL CONTROL IN HAWAII--UP TO 1978.

Ota, A., Mau, R. F. L., Funasaki, G. and Ikeda, J. (Haw. Sug. Plant. Assoc., Box 1057, Aiea, Hawaii 96701, U.S.A.)

Since the 1890's, when Professor Albert Koebele was appointed entomologist of the Republic of Hawaii, classical biological control has been the single most important method of controlling insect and invertebrate pests of Hawaii. Each year a number of new immigrant pests become established and because Hawaii is an oceanic island some of these immigrants become pests since there are no efficient natural enemies.to suppress their populations. It is, therefore, necessary to seek and import their natural enemies. A total of over 600 natural enemies have been introduced and about 240 (c.a. 40%) have become established. About 80% of all purposely introduced natural enemies are insect parasitoids and predators. Over the last 38 years (since 1940), an average of ten exotic natural enemies have been released and about four have become established each year. Almost half of all introduced natural enemies came originally from North, South, and Central America. Since 1969, there has been a total of 12 successful to partially successful cases of biological control. In eight of these cases the control achieved with exotic natural enemies have minimized the need for other methods of control. At the present time, biological control efforts are concentrated on five pest insects, one mite, and two weeds. Although there are certain ecological conditions that favor successful biological control in Hawaii, it is the human efforts that have made it so remarkably successful. The philosophical and conceptual contributions to classical biological control from the work in Hawaii,is also discussed.

12R-3,10 AN IMPORTANT ROLE PLAYED BY NATURAL ENEMIES OF RICE PESTS IN SOUTH AND EAST ASIA.

Wongsiri, N., Tirawat, C., Lewvanich, A. and Yasumatsu, K. (Div. Ent. Zoolo., Dept. Agric., Bangkok-9, Thailand)

Rice cultivation has long been performed without using any insecticides in larger areas of South and East Asia where the high-yielding rice varieties have not been induced. This phenomenon may be attributed to the activity and abudance of natural enemies of rice pests which are almost common in the areas concerned, and even in the areas where double cropping of rice has been in practice for a long year-period. The authors report the results of their long years studies with special reference to the complex and population of both specific and non-specific natural enemies and the characteristic of their effect in suppressing the population of rice pests. Considerations are taken into the methods of conservation of natural enemies, and suggestions are made to the candidate natural enemies for future augmentation into the rice paddies.

12R-3,11 REDUCTION OF PECTINOPHORA GOSSYPIELLA IN COTTON BY IMPORTED PARASITIC HYMENOPTERA

Legner, E. F.

Efforts to permanently establish 14 imported parasitic Hymenoptera on pink bollworm, Pectinophora gossypiella (Saunders), in the lower Colorado Desert of California and Arizona during 1973-79, failed even though field reproduction of 8 species was recorded. The absence of parasites in succeeding years following releases may result from the lack of suitable host stages in springtime. Inundative releases of parasites produced varying levels of P. gossypiella reduction, the best performance being attained with egg-larval Chelonus spp. (Braconidae). A Chelonus sp. nr. curvimaculatus Cameron obtained from NW Australia was most effective, giving an adjusted 69.6% infested boll reduction by Aug. 24th at the equivalent release rate of 6,667 ♀♀ / ha.; whereas, single-field treatments with pink bollworm pheromone Gossyplure gave only 10.8% control. Field applications of parasite-stimulating kairomones did not enhance the performance of Chelonus spp. An expanded search for parasite strains or new species of parasites with extended diapause intensity in SE Indonesia and NW Australia, at high elevations, is recommended to produce the desired host:parasite synchrony.

12R-3,12 AUGMENTING AND CONSERVING FIELD POPULATIONS OF CHRYSOPIDS, COCCINELLIDS AND SYRPHIDS.

Hagen, K. S. (Dept. Ent. Div. Biol. Control, U. C. Berkeley, CA 94720).

By spraying artificial foods (yeast products and sugar) in crops where high aphid or certain lepidopterous pest populations are anticipated, adult honeydew-feeding Chrysopa spp. can be attracted and oviposition induced. Syrphid flies can be attracted and sustained but oviposition is dependent on presence of aphids. Coccinellids can be retained and sustained but egg production will not occur unless some aphids are present.

By strip spraying artificial foods in fields surrounding crops to be treated with a pesticide, chrysopid, syrphid and coccinellid adults searching for food can be prevented from entering fields where they may be killed by pesticides.

12R-4,13 COMPARATIVE PHENOLOGY AND DIAPAUSE OF THE PREDATOR EXOCHOMUS QUADRIPUSTULATUS L. (COL.: COCCINELLIDAE) IN CALIFORNIA AND GREECE.

Katsoyannos, P., Benaki Institute, UNDP/FAO, Kifissia, Athens, Greece, and K.S. Hagen, Div. Biological Control, Univ. of California, Berkeley, Ca 94720.

Exochomus quadripustulatus, a palearctic coccinellid species, was introduced into California from Italy in 1915. The biotype that became established in California does not exhibit the pale form (floralis) which appears in 100% of the Greek populations every year. The biotype in Greece is univoltine with 100% of the populations entering an adult estival diapause induced in June and remains in the pale form until diapause is terminated in October when it assumes the typical dark form. However, the populations remain in loose aggregations until February when they disperse. Short photoperiods terminates diapause. Induction of diapause could not be prevented neither under short or long photoperiods nor various temperatures.

Only a portion of the populations that occur in California is univoltine and enters an estival diapause but does not exhibit the pale form. Short photoperiods terminates diapause. Larvae, pupae and adults can be found in the field throughout the year, indicating that part of Californian populations are multivoltine.

12R-4,14 COMPETITIVE DISPLACEMENT AMONG ECOLOGICAL HOMOLOGUES: THE APHYTIS STORY IN SOUTHERN CALIFORNIA.

Luck, R. and Podoler, H. (Div. Biol. Cont., Univ. Calif., Riverside, CA 92521 USA)

Three Aphytis species have played an important role in the biological control of California red scale Aonidiella aurantii (Maskell) in southern California. Two of these species, A. lingnanensis Compere introduced into southern California in 1947 and A. melinus DeBach introduced in 1957, displaced a previously established congener from all or part of its original geographic range. A. lingnanensis displaced A. chrysomphali (Mercet) and A. melinus displaced A. lingnanensis. DeBach (1966) stated that larvae of A. lingnanensis have a very slight advantage over larvae of A. melinus when both species occur together on the same host. This advantage, however, failed to prevent A. melinus from displacing A. lingnanensis in the field. Therefore, DeBach (1966) concluded that inherent differences in progeny production, as modified by physical conditions--mainly temperature--in particular habitats determined the winner or the rate of displacement. More recent laboratory experiments in which immature stages of both Aphytis species were exposed to high temperatures (32°F constant or a sinisoidal fluctuating temperature of 27-35°C; 24 hr cycle) indicated that A. melinus was better able to maintain female progeny production from the resulting adults than was the case for A. lingnanensis (Kfir and Luck 1979). Comparative studies of ovipositional behavior and the determination of the quantity and sex of the progeny produced indicated that A. melinus is able to utilize a smaller scale size than A. lingnanensis to produce female offspring. Thus, A. melinus is better able to exploit California red scale and the third-stage scale, the scale stage normally attacked by these two species, is not a homologous resource for each species.

12R-5,15 MULTIPLICATION OF EGG PARASITE OF PINE SAWFLIES-ACHRYSOCHARIS RUFORUM K.

Marović,R./Inst.for Forestry and Wood Industry,Belgrade,Yugoslavia/

A large number of eggs was successfully laid down by Diprion pini L.and Neodiprion sertifer Geoffr.in laboratory conditions,under fluorescent light.They were later succssfully parasitized.Also the eggs of N.sertifer which have been laid down in nature were brought,in the period between octobar and march,in the laboratory,where affter being exposed to parasites were successfully parasitized.

The most efficient multiplication of parasites happened when coccons of host and eonimphae of parasite were brought out simultaneously in the culture of black pine in nature.A large percent of parasitism was acheaved,and only 0,1 - 0,3 % of host larvae had hatched from the total number of eggs.

The studied methods are important for reduction and regulation of population size of pine sawflies.

12R-5,16 INTRODUCTION, MASS-RARING AND RELEASING OF *A. lingnanensis* Compere AS A INSECTICIDE TO CONTROL ARROW-HEAD SCALE, *Unaspis yanonensi* (Kuwana).

Manabu Tanaka (Kuchinotsu-Branch, Fruit Tree Research St., Kuchinotsu-cho, Nagasaki, 859-25 Japan)

In Japanese citrus orchards, Arrowhead scale, *Unaspis yanonensis* (Kuwana) and citrus red mite *Panonychus citri* (McG.) are the most serious pests. The scalecides destroy the natural enemies of citrus red mites, following outbreaks severly. From this reson, selective scalecides are necessary to solve citrus red mite problems.

A. lingnanensis was introduced from HongKong in 1972 to control the invaded scale insects, *U. yanonensis*. The wasps parasitized on the host, but could not hibernate in Japan.

Therefore, mass-rearing and their utilization of the parasites as a biotic insecticides have been studied, and succeeded to control as the same level of the scale insect population as the before years. This will contribute to regulate biologically the serious pest, *P. citri* by conserving the natural enemies.

The wasps were mass-produced on the host *Hemiberlesia latanıae* - on pumpkin in insectory. The Japanese veriety, Shintosa was the best pumpkin, which do not decay in high humidity in Japan. The number 1400 wasps per tree were liberated. The rate of fruit infested by the scale was below 5 per cent of the production.

12R-5,17 "INTRODUCTION AND REARING OF Apanteles flavipes CAMERON (HYM.: BRACONIDAE) FOR CONTROL OF THE SUGARCANE BORER Diatraea saccharalis FABR. (LEP.: CRAMBIDAE) IN PERU".

The wasp Apanteles flavipes C., considered as one of the most efficient foreign parasites against the sugarcane borers of the genus Diatraea, has been introduced in Peru in December 1975 from Trinidad W.I.

Mass rearins of this parasite in the laboratory was made on larvae of the D. saccharalis borer reared in the artificial diet "ICIA-F-E-9" and coming from collections in young cane fields.

From 1976 to 1979, a total of 447,431 wasps were liberated in sugarcane plantations of the Cooperative Casa Grande, and from 1977 to 1979 totals of 274,383 and 493,495 wasps, respectively liberated in the Cooperatives Tumán and Pomalca. The liberations were performed in fields with plant cane of 3 to 6 months of age at the rate of approximately 150 adults per hectare.

Samplings for recovering the parasites were made since 1976 in the fields under liberations and in those neighboring them, obtaining up to date 268 cocoon masses which shows its possible adaptation.

12R-6,18 VENTURIA PALMARIS WILKINSON (ICHNEUMONIDAE), A POTENTIAL BIOLOGICAL AGENT AGAINST THE OIL PALM BUNCH MOTH

Ng, K. Y. (Bayer, Malaysia, Kuala Lumpur)

The Oil Palm Bunch Moth, Tirathaba mundella Walker (Pyralidae) is a serious pest of Oil Palm infloresences and fruits in Malaysia. Although several parasites and predators of T. mundella were identified, the larval parasite, Venturia palmaris was found to occur in significant numbers throughout the year. Some aspects of the biology and life-history of this parasite were studied. The poor female to male sex-ratio of progenies of mated and virgin females had been found to be a possible limiting factor in mass-breeding under laboratory conditions. However, survey showed that the above condition was not natural in the field.

12R-6,19 THE PARASITOIDS OF DRYOCOSMUS KURIPHILUS IN JAPAN AND THE INTRODUCTION OF A PROMISING NATURAL ENEMY FROM CHINA.

Murakami, Y. (Fac., Agr., Kyushu Univ., Fukuoka, 812 Japan)

Dryocosmus kuriphilus was first recorded in Japan about 1941 and has been one of the most serious pests of the chestnut tree. It probably entered from China. In Japan 15 species of native parasitoids have been reported, none of which has the ability to control it. Since these were, of course, parasitoids of native oak cynipids originally, they are not adapted themselves to the exotic host. Recently 9 species of parasitoids were found from China. Among them Torymus (Syntomaspis) sp. is presumably host-specific and the most promising one. The first shipment of the galls from Shensi was received in 1975 from which only 7 adults of T.(S.) sp. emerged next spring. A preliminary release test was carried out but the parasitoid was not established. In 1979 an additional shipment of about 2,000 galls was received from Hopei. Presumably about 400 adults of T.(S.) sp. will emerge from these galls.

12R-6,20 FORMICA YESSENSIS AS A BIOLOGICAL CONTROL AGENT OF DENDROLIMUS SPECTABILIS IN KOREA.

Kim, C. H. and Murakami, Y. (Coll. Agr., Gyeongsang Univ., Jinju, 620 Rep. of Korea)

Formica yessensis occurs in Japan, Korea, Ussuri and northeastern China. In Korea the ant has been noticed as a possibly important natural enemy of Dendrolimus spectabilis and it has been believed that the injury by the moth is extremely low in the pine forests where the ant inhabits. The result of the experiment on predation with the physical check method reveals that the ant is extremely effective for the control of the larvae of the moth in early stages but not in mature larvae. By the transplantation of the nest it has easily established in red pine forests if it is not so different in floral and physical conditions from the natural habitat.

12R-6,21 ON THE BLACK SCALE, SAISSETIA OLEAE (OLIVIER), AND ITS PARASITOIDS IN SOUTH AFRICA.

Annecke, D.P. and Neser, S. (Plant Prot. Res. Inst., Pretoria 0001, South Africa)

The Black Scale is restricted in South Africa to the winter-rainfall areas of the Cape Province. It occurs on some cultivated plants and on many native species. Variants of true S. oleae also occur that are of uncertain status. S. oleae is invariably patrolled by ants and is rare and difficult to find in undisturbed native vegetation where unparasitized individuals are hardly ever found on the aerial parts of the plants, the specimens that survive to reproduce being found only with attendant ants on the stems at or below ground level. Already some 45 species of chalcidoid Hymenoptera have been taken as primary parasitoids of the S. oleae complex in the Cape, and the collections are not yet complete. Species are included that appear to pass their lives at or in the litter layer in search of S. oleae. In summer-rainfall areas of the country both S. oleae and many of its parasitoids are replaced in the same microhabitats by other species of Saissetia and by parasitoids some of which display similar behaviour. Conclusions from these observations are, firstly, that the range of native host plants and the array of specialized parasitoids support De Lotto's (1965, 1976) view - arrived at on independent systematic grounds - that S. oleae is native to the winter-rainfall areas of the Cape Province; and, secondly, that the one area of the world that has been quite inadequately exploited in attempts at biological control since the 1890s is the southern and south-western Cape Province - the probable native home of S. oleae.

12R-7,22

Recent Developments in Kairomones Involved in the Parasitoid-Host Relationship

Vinson, S. (Dept. Ent., Texas A&M Univ. College Station, Texas, 77843 USA

The potential of Kairomones for an augmentative approach to biological control will depend, in part, on the portion of the host selection chain from which they are isolated. In addition, the types of behavior they elicit must be studied along with the interaction of the chemical with physical parameters. Several case studies will be presented to illustrate the different behaviors the kairomones may elicit in the parasitoid and the influence certain physical parameters may have on the relationship.

12R-7,23

OVIPOSITION BEHAVIOUR OF APANTELES FLAVIPES (CAM.) AND ITS BEARING ON BIOLOGICAL CONTROL OF GRAMINACEOUS BORERS.

Mohyuddin, A.I., King, E.G. & Inayatullah, C. (Pakistan Station, CIBC, P.O. Box 8, Rawalpindi, Pakistan).

The occurence of strains of Apanteles flavipes (Cam.) adapted to different graminaceous crops has been demonstrated. Host specificity is in part determined by a kairomone produced by a host plant/borer interaction. A. flavipes established in Pakistan, following its introduction from Japan is attracted to frass produced by Chilo partellus (Swinh.) reared on maize and sorghum but not on sugarcane. In contrast the strain established in the U.S.A. shows a preference for sugarcane. Cross breeding of these populations indicates that they belong to the same species, flavipes. A. flavipes from Pakistan was frequently encapsulated by Diatraea saccharalis (F.).

The introduction of a strain adapted to sugarcane from Barbados, Indonesia, Madagascar, Mauritius, the U.S.A., etc., into Pakistan is recommended.

12R-7,24

EFFECT OF RICE SPACING ON THE OCCURRENCE OF BROWN PLANTHOPPER AND PREDACIOUS SPIDERS

Chiu, S. & Chen, B. (Taiwan Agr. Res. Inst., Wufeng, Taichung, Taiwan, 431, ROC)

The occurrence of BPH and predacious spiders in 4 different rice plant spacing viz. 20x15cm, 25x25cm, 30x30cm and 35x35cm were compared in this study. Results indicated that there was no difference among all treatments during the first crop of 1979 since the occurrence of BPH was low. In the second crops of both 1978 and 1979, the number of BPH in all treatments were similar before the tillering stage. However, the BPH density increased much faster in the plots of 20x15cm than the others after the booting stage. Eventually, the 20x15cm plots had the highest BPH count in all treatments. And the different growing stage of rice plants in each treatment affected the population densities of BPH differently.

Started from the booting stage of both first and second crops, the densities of predacious Lycosa and Oedothorax spiders were significantly higher in 35x35cm plots than those of 20x15cm plots. It demonstrated that the environmental conditions of close spacing is not favorable to these spiders.

12R-7,25 Mating Behavior of Parasite Species in the Genus Biosteres.

Harris, E. J. (USDA-SEA-AR, Honolulu, Hawaii 96804)

The mating behavior of Biosteres oophilus, B. tryoni, and B. incisi is described and evidence for the presence of pheromones and their effects given for these species. These results show the way for mass rearing of biosteres parasites.

12R-8,26 Trichogramma Species in Ukraine and Prospects of its Practical Introduction.

L.A. Frantsevich. Inst. of Plant Protection, Kiev, USSR

Trichogramma was obtained from the host eggs, collected during 1975-1979 in forest and field territories, where the laboratory-reared parasites were not released before. Five species of Trichogramma have been found:

T. evanescens Westw. - in grasslands, vegetable plants; from the eggs of moths; the percentage of egg reduction of Mamestra brassicae in the second generation by this parasite reaches up to 90-95%.

T. euproctidis Girault - in brushwoods under the forest canopy, in the apple orchard; from the tortricid eggs as well as from eggs of Orgyia antiqua L. Occures rarely.

T. cacoeciae March. - in the apple orchards, shrubs in meadows; from the eggs of the codling moth and other tortricids, from O. antiqua.

T. embryophagum Htg. - abundantly inhabits shrubs in meadows, forest territories; from the eggs of moths. In the beet field T. embryophagum was obtained from the eggs of Chrysopa.

T. semblidis Auriv. - in the near-water biotopes; from the egg clusters of tabanids.

Instead of T. euproctidis which is usually reared under laboratory conditions in Ukraine, we recommend to use the local ecotypes and to apply T. cacoeciae and T. embryophagum in orchards and T. evanescens in order to control M. brassicae and other noctuid pests in fields.

12R-8,27 BIOLOGICAL CAPABILITIES OF NATIVE EGG PARASITES AGAINST THE SOUTHERN PINE SEEDBUG, LEPTOGLOSSUS CORCULUS.

Fedde, G. and Fedde, V. (USDA For. Serv., Forestry Sciences Lab., Carlton Street, Athens, Georgia 30602 USA).

Biological attributes of egg parasites attacking Leptoglossus corculus were evaluated with a view toward selecting the best for possible use in biological control. Trapping procedures confirmed the presence of 3 species: Gryon pennsylvanicus, Ooencyrtus trinidadensis and Anastatus reduvii. Data on longevity, sex ratios and biotic potential for 2 of these indicate O. trinidadensis may be a good prospect for future release.

12R-8,28

THRESHOLD AND OPTIMUM TEMPERATURES FOR OVIPOSITION BY THE EGG PARASITE, *OOENCYRTUS ENNOMOPHAGUS*. Drooz, A. and Bhattacharyya, H. (USDA For. Serv., Southeast. For. Exp. Stn., P. O. Box 12254, Res. Tri. Park, NC 27709 USA)

Knowledge of temperature parameters is essential to biological control procedures. Laboratory studies of the egg parasite, *Ooencyrtus ennomophagus*, were conducted using eggs of its type host, *Ennomos subsignarius*. The data indicated a Beta function should give a good fit. Minimum, optimum, and maximum temperatures were estimated by fitting the data to the equation: $Y = c(X-m_1)^a (m_2-X)^b$, where Y = % emerged (or oviposited), X = temperature, and a, b, c, m_1, m_2 = constants whose estimates we obtain by fitting the data.

12P,1

Non-neurotoxic insecticide treated flour moths are better parasitized

Mueller Peter J., Frischknecht M.L. and Dorn S.

Ephestia kühniella larvae treated with the non-neurotoxic insecticide Ro 13-5223 develop to permanent larvae which fail to metamorphose. These permanent larvae have a significantly increased body weight in comparison to untreated last larval instars. The treated larvae are readily accepted by the wasp *Habrobracon juglandis* for parasitation and give rise to a normal progeny of wasps. If larvae are exposed for an appropriate time to the parasite more wasps develop and hatch successfully from the treated hosts than from the untreated ones.

12P,2

ENTOMOPARASITES OF INSECTS-GARDEN PESTS IN LITHUANIA. Zayanchkauskas, P., Jonaitis, V., Jakimavičius, A., Stanionytė, A. (Inst. Zool. and Parasitol., Lithuanian Acad. Sci., Požėlos 54, Vilnius, USSR)

A complex of parasitic insects belonging to 87 genera, I2 families was marked out. The abundance, food relations, level of infection and way of development are determined. The characteristics of some biological, phenological and oecological peculiarities of 46 most popular parasites are given. The synchronism of development of species of parasites with all of the complex of parasites and with different species of parasites separately is analized. 3 groups of parasites with different level of synchronism are singled out. The reasons for changes in abundance during various years are discussed. The determinant of all of the complex of parasites is given.

Section 13.

Integrated Pest Management.

13S-1,1 MATHEMATICAL MODELS FOR PEST MANAGEMENT - STRATEGY, TACTICS AND POLICY. Conway, G.R. (Centre Envir. Tech., Imperial College, London, U.K.)

The utility of mathematical models needs to be judged in terms of the level at which guidance in pest management is being sought or offered. Models can be usefully divided into the strategic which provide general guidelines on the appropriate techniques of control, tactical which provide detailed advice on day to day decisions, and policy which address regional and national questions. Examples of all these classes of models are given.

13S-1,2 A POPULATION DYNAMICS MODEL OF THE GREEN RICE LEAFHOPPER AND ITS IMPLICATION TO PEST MANAGEMENT

Hokyo, N.(Okinawa Pref. Agric. Exp. Sta., Sakiyama-cho, Naha, 903 Japan)

The green rice leafhopper(GRL), *Nephotettix cincticeps* Uhler, repeats 4 generations a year on the seasonal succession of rice plants(summer-autumn) and graminaceous weeds (winter-spring) in the middle and southwestern parts of Japan and is important as a vector of the rice dwarf virus(RDV). The 6-year life table study of GRL(Hokyo and Kuno, 1977) was consulted to construct a graphical model of the seasonal population build-up and decline. The most remarkable feature in the model was an extremely high total mortality(99.9 % on average) from the 3rd generation(G-3) adults which produce the overwintering generation(G-0) in autumn through the emergence of G-0 adults in next spring. The average density of G-0 adults and that of G-1 ones invading into paddy field were almost equally balanced(average replacement rate was near unity) although the annual variation of G-1 adult density was the greatest among the all. Such an equilibrium state could be prepared by the density dependent growth of the paddy field population where the density dependent emigration of G-2 and G-3 females seemed to play a key role in the compensatory increase of the fecundity of resident females. Hence, the central point of the pest management is how to reduce the reproduction rate from G-0 adults to G-1 invading ones so as to keep the RDV infection rate of young rice plants below the economic level.

13S-1,3 A SIMULATION MODEL OF CARBAMATE INSECTICIDES RESISTANCE OF THE GREEN RICE LEAFHOPPER, *NEPHOTETTIX CINCTICEPS* UHLER. Miyai, S. and Kiritani, K.(Div.Ent.,Kochi Prefec.Inst.Agr. & Forest Sci.,Kochi,781-21 Japan)

A model was developed to simulate by computer the development of resistance to carbamate insecticides in the green rice leafhopper. This resistance is known to be caused mainly by a resistant allel (R) at one locus that is incompletely dominant over a susceptible one (S), so the level of resistance can be measured by the frequency of R allele in the population. With the model the effects of degree of dominance, initial frequency of R allele, dispersal rate, kill rate of insecticide, and frequency of insecticide applications were studied by changing the related parameters. It was assumed that the population consisted of a hexagonal array of 100 subpopulations and that dispersal occurred from each subpopulation to the 6 nearest neighbor ones every generation. The number of individuals in each subpopulation was assumed to grow by $N_{t+1} = \lambda N_t^{1-b}$ with random mating among the three genotypes, RR, RS and SS.

Simulation shows that in most cases high level of resistance developed eventually, but that the time required for attaining this level was greatly varied depending on the conditions. It was suggested that the development of resistance could be sufficiently retarded by when-necessary insecticide application with a control threshold. The results obtained by using appropriate parameters were rather consistent with some real situations where the green rice leafhopper developed high level of resistance in only four years in the case of applying insecticides every generation.

The effect of some anti-resistant agents on retarding the development of resistance was also evaluated by simulation.

13S-1,4 A POPULATION DYNAMICS MODEL OF THE WESTERN TENT CATERPILLAR (MALACOSOMA CALIFORNICUM PLUVIALE). Thompson,W.A. (Forestry & Env. Stud., Duke Univ., Durham NC 27706, USA).

A stochastic simulation model of a western tent caterpillar population is presented which embeds the life stages of the insect in a patchwork of variable local climates, mimicking the climatic mosaic of the Saanich Peninsula, British Columbia. The model is designed for examining the effects of interaction between population size, distribution and quality, and spatial and temporal variability in the environment. Key elements in the model include: spatial grids of host density, obstacles to dispersal and local climate; larval growth and mortality rates which vary with larval quality, instar, colony composition and weather; adult emergence, reproduction and dispersal which depend on individual quality and larval nutrition; and viability and quality of progeny as a function of maternal history. The model is used to deduce the effects of population and environmental heterogeneity on survival and outbreak of the insect population, and to examine how knowledge of these effects might be useful in controlling a population.

13S-1,5 A MODEL STUDY OF THE POTENTIAL OF THE CINNABAR MOTH FOR THE CONTROL OF THE WEED, RAGWORT. Dempster,J.P.(Inst. Terrestrial Ecology,Monks Wood Expt.Stn., Abbots Ripton,Huntingdon,PE17 2LS)

A model of the interaction between populations of the cinnabar moth and its food plant, ragwort, based on 10 years data from a field study of the moth, was published by Dempster & Lakhani (1979). Further analyses of this model are described, together with tests of its applicability to cinnabar/ragwort populations in other localities.

13S-1,6 THE STRUCTURE AND BEHAVIOR OF INSECT/FOREST SYSTEMS

McNamee,P.,J.M.McLeod,C.S.Holling,W.C.Clark.(Inst. Anim. Res. Ecol. Univ. B.C.,
Vancouver, B.C. Canada. V6T-1W5.

Analysis of simulation models of the eastern spruce budworm/fir-spruce(Clark et al, 1979), eastern black-headed budworm/balsam fir(McNamee, 1979), jack pine sawfly/jack pine (McLeod, 1977), European pine sawfly/red pine(Wallace and Griffiths, 1979), and western spruce budworm/fir(CANUSA, 1980), models of 5 systems with good data bases shows:

a) there are 4 qualitative classes of insect/forest system behavior.
b) these classes can be explained in terms of the equilibrium structure(number and shifting of equilibria(Peterman et al, 1979) of the defoliator, foliage, parasitoid and/or disease complexes, and forest variables.
c) the equilibrium structure for any insect/forest system arises out of a small set of ecological processes.
d) the prescence, absence, and form of the processes can be predicted by a small set of simple biological information, such as the life history of the defoliator.

This framework is applied to 16 other insect/forest systems, many with poor data bases. Results show the framework to have good predictive power over a wide range of insect/forest systems.

The findings have strong implications for a) data requirements in a forest pest management program and b) development of alternative pest management strategies.

13S-2,7 PLANT-HERBIVORE INTERACTIONS: ECOLOGICAL, ECONOMIC AND EVOLUTIONARY OVERVIEW.

Gutierrez, A. P. and Regev, U. (Div. Biol. Control, Univ. of Calif., Berkeley, CA. 94720, USA)

In economics, the unit of flow between systems is currency, gold or some other unit of commonly accepted value. In ecology, the unit of transfer between trophic levels or ecosystems is energy, inorganic nutrients or some unit which has survival value. Both systems evolve through time, but those systems which fail to reach accommodation with other systems they interact with ultimately go extinct. Crop systems are a mix of the natural and man's economies. This paper examines these relationships and explores the implications of them on IPM.

13S-2,9 LIFE TABLE APPROACH FOR THE DETERMINATION OF CONTROL THRESHOLD.

Koyama, J. (Okinawa Pref. Agric. Exp. Stn., Sakiyama-cho, Naha, 903 Japan)

To determine the control threshold of an insect pest, at least two types of information are needed. One is the relationship between injury and yield loss and the other is the prediction of injury before the time when control measures should be applied. For the prediction of injury, the life table approach is seemed to be useful. Nakasuji and Matsuzaki (1977) predicted total amount of plant material consumed by larvae of the tobacco cutworm, Spodoptera litura, from egg mass density by means of life tables of the insect. Koyama (1977) studied the life table of the 1st generation of the rice stem borer, Chilo suppressalis, and justified an equation predicting the percentage of dead hearts from that of injured leaf sheaths of rice plant. By the life table study, Emura and Kojima (1978) tried to predict the density of 3rd instar larvae of the rice leaf beetle, Oulema oryzae, which mainly cause injured leaf of rice plant, from the density of egg masses. In these studies, the valiability in the survivorship curves of the insect was a problem for predicting the injury.

13S-2,10 SYSTEMS APPROACH TO THE MANAGEMENT OF THE RICE BROWN PLANTHOPPER WITH SPECIAL EMPHASIS ON YIELD LOSS ASSESSMENT.

Chen, C. N. Plant Protection Center (Taiwan); Taichung Hsien, Taiwan 431, R. O. C.

Systems approach depicted by Iwao's (1970) conceptual model was adopted to develop a management program for the rice brown planthopper in Taiwan. Although the program is still in its developmental stages the approach is proved to be fruitful. Major activities to be discussed include (1) the development of a sampling plan for pest population estimation and methods for crop surveillance; (2) the establishment of control thresholds through yield loss assessments; (3) Evaluation of management components; (4) demonstration of an "economic control program" in the field for effective implementation; and (5) improvement of management tactics. On-going projects dealing with population ecology of the brown planthopper and others hopefully will ultimately lead to the development of a better management system for this rice key pest.

13S-3,12

DEVELOPMENT OF COMPREHENSIVE, UNIFIED SYSTEMS OF INTEGRATED PEST MANAGEMENT FOR MAJOR CROPS IN THE UNITED STATES. Frisbie, R. E. and Adkisson, P. L. (IPM Coord., Texas A&M Univ., College Station, TX 77843, USA)

The Consortium for Integrated Pest Management is comprised of 17 participating universities in the United States. The universities have come together to develop a comprehensive, indisciplinary research program for the management of pests attacking four major U.S. crops. These crops, alfalfa, apple, cotton, and soybean have several pest management principles in common. Although unique in their regard, the basic methods of conducting research within the context of agroecosystems, an organized systematic approach to solving pest problems, is shared between research objectives of these diverse production systems. The goal of the universities involved in the integrated pest management consortium is to develop research to enlarge basic knowledge of major managed ecosystems and to use this knowledge in the development of ecologically-oriented systems of management that hold pest populations below crop damaging densities, are less energy dependent, optimize economic returns to producers and society, and cause a minimum of damage to the environment. This major research project is administered through Texas A&M University and the cooperating universities. One of its major thrusts is to develop economically sound systems of integrated pest management and to deliver these systems to the farm level by the way of a Cooperative Extension Service and other methods of education. The overall design, administration, and results of this consortium are discussed.

13S-3,13

Current Status of IPM in People's Republic of China.

Kai-lou Shin (Dept. Biol. Futan Univ. Shanghai)

Since 1975, the guiding policy of plant protection of PRC "prevention as the principal method, and carring on integrated control" were decided, much researchs and experiments were made by the agricultural research institute at various level and then propagated through demonstration field to large areas. Although certain performances were obtained, but also remained some problems which need further researchs.

Owing to vast territory of our country, difference of climatic conditions, crop kinds and varieties, cultural traditions etc. at each locality, it is very difficult to describe IPM of our country in short statement. Therefore I intend to present a few important pest; such as migratory locust, paddy borer of rice, as examples to explain the current status of IPM in our country.

13S-3,14

APPLICATION OF INTEGRATED PEST MANAGEMENT IN GREENHOUSES, RECENT SITUATION AND FUTURE POLICY. Woets, J., Ramakers, P.M.J. and Lenteren, J.C. van (Dept. Ecology, Leiden University, the Netherlands)

Spider mite (*Tetranychus urticae*), an important glasshouse pest, developed resistance against organophosphorous compounds during the 1950's. Therefore biological control possibilities were studied and an efficient predatory mite, *Phytoseiulus persimilis*, was found. Application of this biological control method was possible when rather selective fungicides became available for mildew control. After using this system for some years the greenhouse whitefly (*Trialeurodes vaporariorum*) became so abundant that frequent application of insecticides was necessary, which however interfered with biocontrol of spider mite. A good parasite for whitefly control was already known (*Encarsia formosa*) and development of a reliable control method was quite easy. Application of biocontrol in Dutch glasshouses increased fast since then, because growers have a positive attitude towards the use of natural enemies and clearly see the advantages of biological control over chemical control under glasshouse conditions. We now study natural enemies of some other organisms that either developed less frequently to pest levels or occur in crops of a smaller total acreage (e.g. tomato leafminer, onion thrips, aphids). Another problem is to find a substitute for *E. formosa* because new tomato varieties will soon be available that can be cultured at temperatures 10°C lower than those that are used now. Integrated pest management schemes for several crops will be presented and factors limiting application will be discussed.
For a review of the biological control situation in Dutch glasshouses see: J.C. van Lenteren *et al.*, 1980. Integrated control of vegetable pests in glasshouses. In: Integrated control of pests in the Netherlands (P. Gruys & A.K. Minks, eds.). Pudoc, Wageningen, 300 p.

13S-3,15 IPM IN APPLE ORCHARDS: IMPLEMENTATION AND BARRIERS.

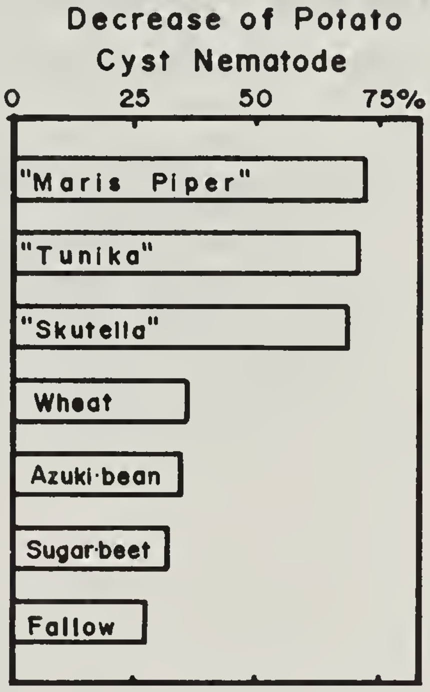
Croft, B. A. (Dept. Ent., Pest. Res. Ctr., Mich. St. Univ., E. Lansing, MI 48824)

The application of IPM technology on apple in this presentation is broken into two areas for discussion purposes: Implementation Research and Implementation. The former is a precursor research phase to design new implementation tools including means for carrying out biological monitoring (pest sampling), environmental or weather monitoring, extension delivery and tactics application etc. It often involves feasibility analysis, economic assessment and demonstration education using a prototype system before a full scale program is actually implemented. Implementation per se, is the actual in field use of a particular technology on a widespread scale in the field. Examples of both implementation research and implementation of IPM in North American orchards are discussed as well as barriers hindering more widespread application. Specific topics treated include biological monitoring systems, environmental monitoring systems, extension delivery systems, integrated mite control, pheromone control, sterile male control, improved pest timing models and insecticide resistance management.

13S-3,16 UTILIZATION OF RESISTANT VARIETY UNDER IPM SCHEME IN CONTROLLING SOIL-BORNE PESTS.

Inagaki, H. (Cen. Agr. Exp. Sta., Konosu, Saitama, 365 JAPAN)

Resistant varieties(RV) of potatoes and soybeans are useful not only to evade the damage caused by the cyst nematodes but also to control the nematodes themselves. Since the nematodes cannot mature in the roots of RV, the population level is decreased after cropping of RV. The decrease rate is about 75% per one crop with either one of the resistant potato varieties "Maris Piper", "Tunika", or "Skutella", for example(Fig.). Therefore, various RV have been developed and utilized in combination with crop rotation system to control potato cyst nematode(PCN) and soybean cyst nematode(SCN). While, as the case of planting RV in commercial fields is increased, the occurrence of resistance-breaking races of the nematodes has become an important subject. There are 2 species and 8 races in PCN and 5 races in SCN. It is generally considered that the appearance of the races is a result of the function of cropping of RV as a selective pressure on a local nematode population which has originally been mixed with various races at different density levels. Development of multiple resistant varieties is in progress to solve this problem.



13S-3,17 IMPLEMENTATION OF INTEGRATED PEST MANAGEMENT OF CITRUS CROPS IN JAPAN.

Ohkubo,N. (Nagasaki Pref.Exp.Stat.,Nagasaki,856-01 Japan)

In Japan, insecticides for controlling citrus pests generally are being sprayed 4-6 times a year, according to the fixed schedule, and the amount and frequency of spraying are not necessarily reduced even if the pest density is lower than usual. Then, it is urgently needed to establish a satisfactory forecasting system of pest populations. The arrowhead scale, Unaspis yanonensis and citrus red mite, Panonychus citri are the most important pests of citrus trees in Japan. A systems model for the integrated control of U. yanonensis has been developed by Inoue & Ohgushi (1976). The model includes the population dynamics of the scale and process of tree withering in relation to the scale density. Spray of machine oil in winter season is thought to be most effective to reduce the overuse of synthetic insecticides which may rise the red mite problem. The method of the optimal use of the machine oil was simulated by using the systems model and the results were compared with actual data in terms of the timing, amount and intensity of machine oil spray. Natural controlling factors seem to be more effective in the population dynamics of red mite than in the arrowhead scale. Control method of the red mite will be much improved if the frequency of spray of synthetic insecticides for the arrowhead scale can be decreased. In the near future, the tactical model of the whole system including all the pests will be used for the integrated pest management of citrus orchard in Japan, though control methods for the minor pests except insecticides have to be developed.

13S-4,18 BARRIERS TO I.P.M. IN JAPAN

Manabu Tanaka(Kuchinotsu-Branch,Fruit Tree Research St.,Kuchinotsu-cho,Nagasaki ,859-25)
Japan

From 1971 to 1975, Ministry of Agriculture and Forestry of Japan ,conducted the Researching Approaches to Integrated Pest Management against following crops and insect pests: Rice plant, *Naphotettix cincticeps* (Hemi.,Jassidae); Vegetable,*Prodenia litura* (Lepi.,Noctuidae); Citrus, *Unaspis yanonensis* (Hemi., Diaspidae);*Panonychus citri* (Acar.,Tetranychidae) ; Apple andTea, *Adoxophyes orana* (Lepi., Torcidae);Mulbery, *Glyhodes pyloalis* (Lepi.,Pyralidae) ; *Pseudaulacaspis pentagona* (Hemi.,Diaspidae) Forest,*Dendrolimus spectabilis* (Lepi.,Lasiocampidae), *Cinara todocolus* (Hemi.,Lasiocampidae) and *Catarinia inouyei* (Dipt.,Cecidomydae).

Following control agents and tactics combining chemical insecticides; Biological control (Entomophagus and Microbial), Pheromone and Economic Injury Levels were studied.

But these apprаches ended in each separated studies and have not been integrated,and I.P.M. technique could not been applied practically.

From this results,the barriers of I.P.M. in Japan are considered to be weakness of new control agent developments and integration strategies of these agents, and too low economic injury levels, that is, cosmetic problems especially.

Not only the developments of new technique, but also economic and educational strategies will be necessary to solve these barriers.

13S-4,19 AVAILABILITY AND ADEQUACY OF DIFFERENT TACTICS OF PROTECTION FROM PESTS. Rosen, D.

(Dept. Ent., Hebrew Univ., Fac. Agric., Rehovot, Israel)

Effective pest control is an absolute necessity in modern agriculture. The advantages and limitations of chemical, cultural, autocidal and biological methods of control are discussed, with a view to the development of integrated pest management. The importance of ecological information, economic thresholds, education and extension is emphasized.

13S-4,20 ROLE OF CHEMICAL INDUSTRY IN INTEGRATED PEST MANAGEMENT. Fujita, Y.

(Sumitomo Chem. Co. Ltd., Takarazuka, Hyogo, 665 Japan)

Despite their several adverse effects on non-target organisms, synthetic pesticides have played an important role in I P M programs. This situation will not change drastically in the foreseeable future. It is therefor expected on the part of chemical industry to develop more selective ways of using synthetic pesticides in I P M. The speaker will introduce several examples of insecticidal compounds of higher target specificity. He will also discuss relevant point at issue to meet these needs.

13S-4,21 PLANT PROTECTION IN THE COUNTRIES OF THE EUROPEAN COMMUNITIES AND EFFORTS TO DEVELOP INTEGRATED PEST MANAGEMENT. Cavalloro,R. (Commission of the European Communities,Biol.,J.R.C. Ispra, Italy).

Investigations and preliminary studies on the use of methods of biological and integrated control in agriculture have led the Commission of the European Communities to carry out an action program in this field, starting in 1979. Meetings of experts from the nine Member Countries of the European Communities have permitted to define the following fields of major interest: 1. Fruits (apple, citrus and olive orchards); 2. Vegetables (cabbage and carrot crops); 3. Cereals. At least in a first stage, European Community action will be focused on these fields.

Research projects proposed by the major agricultural organizations in the Member Countries working on these problems were evaluated. As a result, the C.E.C. accepted to aid 23 different research institutes by financing, in general 50% of the cost of the projects proposed; this financial support is combined with a control of the correct execution of the projects. Furthermore, the C.E.C. organizes expert meetings on subjects of particular interest, as well as an exchange of research workers in order to improve their training. Figures on surfaces cultivated and on production in the three fields of interest are given. The specific plant protection problems are analyzed, as well as the main pests to be controlled by implementing Integrated Pest Management.

13S-4,22 BIOLOGICAL, SOCIOECONOMIC AND POLITICAL BARRIERS TO INTEGRATED PEST MANAGEMENT. Corbet, P.S. (Dept. Applied Biology, Univ. of Cambridge, Cambridge, CB2 3DX, UK)

Barriers to the implementation of integrated pest management (IPM) become evident when the extent to which effective programs are adopted by practitioners is matched against an accepted definition of IPM. So, to be operationally useful, such a definition must make clear which programs do, and which programs do not, meet its specifications. The barriers to be considered result from prevailing attitudes to resource management, which in turn reflect the interplay between, on the one hand, basic human behavioural traits and, on the other, certain recent developments which have moulded our cultural and technological environment and thus limited the kind of decisions we can make in it. Specific examples illustrate the extent to which recent attempts to remove or mitigate such barriers have succeeded. The likelihood of certain barriers persisting is considered in the light of present socioeconomic trends, both in developed and developing countries.

ADMINISTRATIVE BARRIERS TO PEST MANAGEMENT.

13S-4,23 Beirne, B.P. (Simon Fraser University, Burnaby, B.C., Canada)

The difficulty in changing administrative systems is a major barrier to effective pest management. Examples discussed are: (1) government-applied procedures, such as classical biological control, that are not compatable with government administrative procedures; (2) a government status quo, such as the chemical control program for olive insects in Greece, that is difficult to change; and (3) the resistance to integration by educational systems where pest management subjects are segregated into different departments and faculties. An example of (3) is the program at Simon Fraser University for training professional pest managers.

13S-4,24 CONSTRAINTS IN THE PRACTICAL IMPLEMENTATION OF INTEGRATED PEST CONTROL : CONCLUSIONS AND RECOMMENDATIONS OF THE IOBC BELLAGIO CONFERENCE 1980. Mathys, G., EPPO, 1 rue Le Nôtre, 75016 Paris (France)

Experience gained in technologically highly advanced countries proves that Integrated Pest Control (IPC) strategies has both economic and environmental benefits and should be encouraged in both research and operational programs. FAO which has advocated this strategy since the mid sixties is currently engaged in several global IPC programs in the developing world.

However, despite all these advantages, implementation of IPC's is very slow. It appears that there are bottlenecks which oppose the proper technology transfer.

One way of acting is to simplify the IPC systems since farmers are generally afraid to abandon routine spraying whether it is needed or not and to start what they consider a difficult scouting with pest population evaluations allowing to take measures when economic thresholds are exceeded.

Simplifying the IPC systems, recognizing the various technical socio-economical, economical, organizational, educational and commercial constraints and seeking ways of removing them will be the objective of a task force convened at the Rockefeller Foundation Centre at Bellagio (Italy) from 30 May to 4 June 1980.

The results of these deliberations will be presented.

13R-1,2 COMPUTER-BASED COTTON PEST MANAGEMENT IN AUSTRALIA. Hearn,A.B., Ives,P.M. Room,P.M., Thomson,N.J. and Wilson,L.T. (Cotton Res.Unit,CSIRO, Narrabri, Australia)

A pest management system incorporating data handling and decision making by computer was designed to exploit natural mortality of pests and the ability of cotton to compensate for damage, to minimise selection for insecticide resistance in pests and to be easily implemented and updated. A key component is comparison of the observed performance of a crop with that needed to achieve a specified yield. The system gave promising results during three seasons of experimental use. This paper reports developments to make the system more reliable and practical for commercial use. Threshold population densities of pests have been defined more dynamically in terms of crop performance. Labour requirements have been reduced by using sequential sampling of insects on terminals only and by simulation of fruit development during extended intervals between sampling. Decision making has been refined using recent experience. Results of using these developments in the 1979/80 season are presented.

13R-1,3 INTEGRATED PEST MANAGEMENT FOR THE RANCE CATERPILLAR,(HEMILEUCA OLIVIAE) COCKERELL. Huddleston, E. and Owens, J.(Dept. of Ento. and Plant Path., N. M. St. Univ., Las Cruces, NM)
The Pilot Pest Management Program for the range caterpillar is the first rangeland IPM program in the United States. Helicopters are used for initial population assessment and field scouting is used to delimit areas above the economic threshold. Selective insecticides, including insect growth regulators and microbial pesticides have been evaluated. A computer simulation model, based on field life tables and egg fertility and parasitism, is used in control recommendations.

13R-1,4 ARTIFICIAL DISSEMINATION OF GRANULOSIS VIRUS OF ADOXOPHYES ORANA FASCIATA WALSINGHAM INTO APPLE ORCHARDS: EVALUATION BY A POPULATION MODEL.

Shiga, M., Oho, N. (Fruit Tree Res. Stn., Tsukuba, 305 Japan) and Nakazawa, H. (Nanshin Agric. Exp. Stn., Shimoina, Nagano, 399-31 Japan)

The granulosis virus of Adoxophyes orana fasciata which was mass-propagated by the method developed by Yamada and Oho (1973) was sprayed in apple orchards, and population surveys on the tortricid were conducted. It cuold be demonstrated that dissemination caused a remarkable rise in the infection rate depending on the larval density, not only in the generation sprayed but in the subsequent two generations (Shiga et al. 1973). A population model was constructed by revising the preliminary one proposed by Ito et al. (1977). Our model covers larval survival mechanism after virus infection, parasitism, predation and some other factors, while interrelations between these factors are also considered. Rate of increase from the pupal stage to the larval stage in the next generation is strongly influenced by density. Percentage of fruits injured by the larvae is also expressed as a function of larval densities in the 2nd and 3rd generations. Results of simulated calculation by the model suggest that a single spray of the virus in the 1st generation could reduce not only the number of A. orana fasciata larvae in the 2nd and 3rd generations, but also the degree of fruits injured by this insect.

13R-2,5 TESTING THE SIDE EFFECTS OF PESTICIDES ON BENEFICIAL ARTHROPODS:

Hassan, S.A. (Institute for Biological Pest Control, Darmstadt, Germany Fed.Rep.)

The Working Group "Pesticides and Beneficial Arthropods" (WPRS/IOBC) which aims to coordinate the testing of pesticides on beneficial arthropods was established in 1974. Standardized guidelines for testing the side effects of pesticides in the laboratory on the beneficials: Trichogramma cacoeciae (Trichogrammatidae), Coccygomimus (Pimpla) turionellae (Ichneumonidae), Chrysopa carnea (Chrysopidae), Pales pavida (Tachinidae), Leptomastix dactylopii (Encyrtidae), Coccinella septempunctata (Coccinellidae) have been developed by group members and several more guidelines for additional natural enemies are in progress.

Future activities of the Working Group will include the development of guidelines for more natural enemies, the arrangement for series of pesticides to be tested, the development of laboratory and semi-field tests to examin the initial toxicity as well as the duration of harmful activities of pesticides.

13R-2,6 CONTROL OF EUROPEAN RED MITE BY OVICIDAL ACTION OF CGA-29'170 ON WINTER EGGS.

Bachmann F. & Scheurer R. (CIBA-GEIGY Basel)

The application of a selective chemical active against winter eggs of European Red Mite (Panonychus ulmi) would fit well in a program of integrated control in deciduous fruits. By examining the biological activities of synthetic derivatives of the juvenile hormone we have found that CGA-29'170 is an excellent ovicide on summer and winter eggs of this tetranychid. The efficacy does not depend from the date of application but is very much influenced by the quality of spraying or the degree of coverage. If the compound in the dosage of 0.05 % is well applied, the mite population stays below the economic threshold for several months or even for the whole season.

13R-2,7 Ro 13-5223, a novel non-neurotoxic insecticide with a broad activity spectrum

Dorn, S., Frischknecht, M.L., Martinez, V. and Fischer, U. (Dr. R. Maag Ltd., Biol. Lab., CH-8157 Dielsdorf, Switzerland)

Ro 13-5223 is a non-neurotoxic insecticide with a novel chemical structure.
It exhibits a strong juvenile hormone type of activity against many pests while being harmless to various beneficial organisms. Ro 13-5223 has a favourable persistence on plants, stored goods and in water.
The product is of particular interest for the control of scale insects, psyllids, various lepidopterous species, mosquitoes, stored product pests and fire ants. It also controls insects which are resistant to conventional insecticides.

13R-2,8 RECENT DEVELOPMENTS IN GRAIN PROTECTANTS IN AUSTRALIA.

Bengston, M. (Dept. Primary Industries, Meiers Rd., Indooroopilly 4068 Australia)

In Australia, grain protectants are typically required to keep grain insect free for up to 9 months storage. Malathion resistance is widespread but treatment combinations have been shown to be effective in extensive laboratory and field trials throughout the Australian grain growing regions. Bioresmethrin, carbaryl, permethrin, phenothrin or pyrethrin are effective against *Rhyzopertha dominica* and chlorpyrifos-methyl, fenitrothion or pirimiphos-methyl are effective against *Sitophilus oryzae*, *Tribolium castaneum* and remaining species of lesser importance. Decamethrin and methacrifos are effective against all species. All pyrethroid insecticides are synergised by piperonyl butoxide. The rates of breakdown of these compounds can be predicted over the range of prevailing grain temperatures and moistures.

13R-3,9 INTRASPECIFIC ATTRACTANTS OF THE HIDE BEETLE *DERMESTES MACULATUS* (DE GEER)

Levinson, A.R., Levinson, H.Z., Francke, W. (Max-Planck-Institute of Behavioural Physiology, 8131 Seewiesen, West Germany)

Male *Dermestes maculatus* possess an exocrine gland linked to a sclerotized outlet by an efferent canal underneath the fourth abdominal sternite. A hexane extract of such glands evoked relatively high receptor potentials in the antennae of hide beetles (3.0-4.0 mV/gland equivalent), the threshold of stimulation being about 10^{-5} of a gland equivalent. The gland extract preferably attracts female *D. maculatus* and promotes the recognition of sexually mature males. Newly emerged males reveal a group of rudimentary cells developing into a secretory gland within approx. 14 days (at 25°C), during which period the attractant production gradually increases up to a maximal level.
Electrophysiological recordings from the terminal antennal segment revealed that isopropyl Z-9-tetradecenoate (myristoleate), isopropyl Z-5-dodecenoate, isopropyl Z-7-dodecenoate as well as isopropyl Z-9-dodecenoate (lauroleate) were the most active gland components emitted. The olfactory specificity of the above attractants is corroborated by the fact that removing the double bond from the molecules reduces the activity by about 1/2, while replacing the isopropyl by an ethyl group or by hydrogen results in almost complete loss of the activity.
Female hide beetles also emit an attractant causing precopulatory excitation in sexually mature males; the composition of this sex attractant has not yet been completely elucidated. Both sexes of *Dermestes maculatus* excrete faecal fatty acids which induce aggregation and stimulate feeding; the composition of those attractants will be reported elsewhere.

13R-3,10 Effect of types of traps on the efficiency of pheromone activity.

A. Maher Ali & Moustafa Rizk. Agric. College, Assiut Univ., Egypt.

The role of trap type in the attraction of the male moths of the cotton leaf-worm Spodoptera littoralis to pheromone has been studied. Three types of traps were applied: dry, water and sticky in addition to a light trap for comparison. The dry one was superior specially under light or normal infestation. With high infestation of the pest, the efficiency starts to decline.

13R-3,11 FIELD STUDIES OF THE OLIVE FRUIT FLY SEX ATTRACTANT PHEROMONE. Haniotakis, G. (Biology Dept., "Demokritos" N.R.C., Aghia Paraskevi Attikis, Greece)

Female olive fruit flies release a multicomponent sex pheromone which acts as male attractant. Although quantitative differences in the pheromone components were revealed between wild and lab-cultured and between irradiated with gamma-rays and non-irradiated insects, pheromone communication between these insect categories was not affected. Natural pheromone collected from lab-cultured females was very effective in the field in attracting both wild and lab-cultured males. The efficiency of pheromone baited traps in recovering released males during the first two days from release was 57.2%, 40.1%, 36.7% and 20.7% with trap densities of 2, 1, 0.5 and 0.27 traps/tree, respectively. Pheromone baited traps are as effective as odor or color traps used for this insect. Combination of pheromone with either odor or color traps was more attractive to male flies than any one trap alone. Pheromone traps operate inside tree foliage only. Males within a network of traps baited with equal pheromone concentrations orient toward the nearest trap upwind, but traps at the upwind edge of the network tend to catch more flies than total trap average. Males within a trap network with unequal pheromone concentrations seem to orient toward the nearest trap upwind with the highest concentration.

13R-3,12 EFFECTS OF GAMMA-RAY IRRADIATION AND HOLDING CONDITIONS ON THE DEVELOPMENT OF ADULT ORIENTAL FRUIT FLY (*DACUS DORSALIS*). Cheng, E.Y. (Dept. Applied Zoology, Taiwan Agri. Res. Inst. Wu-feng, Taichung, Taiwan, China)

In order to improve the survivorship of gamma-ray irradiated oriental fruit fly, *Dacus dorsalis* Hendel, several density parameters of the holding condition were tested against the mortality of emerged flies. Results of the study demonstrated that : (1) the gamma-ray treatment at 13 Krad along caused the rate of incompleted emergence tripled from 6.5% to 19.7% which has no relation to the degree of crowding; (2) at different severity, crowding in the experimental conditions resulted 13-30% mortality in the imago form and 5-15% mortality in the normal adult form; (3) in analyses, the mortality resulted from crowding had the highest correlation to the total surface available to flies; and (4) the survivorship was successfully increased by providing more surface area inside cages.

13R-4,13 Analysis of spatial distribution and estimation of density of greenhouse whitefly population in greenhouses. Yano, E. (Veg. & Ornam. Crops Res. Stn. Tsu-City, 514-01 Japan)

Spatial distribution of greenhouse whitefly population infesting tomato plants in small glasshouses was analyzed by the method of analysis of variance and $\overset{*}{m}$-m statistics. Each leaf was divided into seven leaflets, which were used for the smallest sampling units. It was found that whitefly populations distributed contagiously between leaves for all developmental stages. On the other hand, they showed random distribution between plants. Using the method of three-stage sampling (Kuno, 1977), a sampling method has been developed for the census of whitefly populations. Besides, methods to detect the initial infestation of whitefly adults are to be described.

13R-4,14 TEMPERATURE-DEPENDENT DEVELOPMENT RATE FUNCTIONS. Allen, J. C. (Univ. Fla., IFAS, Agric. Res. and Educ. Ctr., P. O. Box 1088, Lake Alfred, FL 33850 USA)

The development rate of most organisms depends on temperature according to an asymmetric, unimodel function which rises to a maximum at the optimum temperature and falls to zero at the upper and lower temperature limits. The problem of simulating temperature-dependent population growth requires that the development rate function be integrated, temperature being a time function of some sort. Several functions have been suggested to represent development rate the simplest being a straight line (the degree-day method), the most complex being the enzyme kinetics formula of Sharpe and Dimichel (1978). While the degree-day approach results in a simple integration, the much more accurate Sharpe and Dimichel formula cannot be integrated in closed form. Other formulas such as Stinner et al. (1976) and Logan et al. (1978) are compared and their relative merits are discussed.

13R-4,15 THE ROLE OF REMOTE SENSING IN INTEGRATED PEST MANAGEMENT. Polhemus, John T. (Martin Marietta Corp., P.O. Box 179, Denver, Colorado 80201 USA)

Remote sensing is potentially an important tool in integrated pest management of tsetse flies, desert locusts, western U.S. rangeland grasshoppers, and cabbage loopers. Study field work and selected trials show that remote sensing requirements for these diverse groups are very different. Although the scanners of the LANDSAT and NOAA TIROS series are valuable, aerial photography and radar from both spacecraft and aircraft are also useful. Resolution requirements vary from 1m to 1km in various spectral bands. The temporal coverage required varies from 12 hours to weekly or monthly. Parameters to be monitored include temperature, rainfall, soil moisture, vegetation cover and specific habitats.

13R-4,16 MANAGEMENT OF CABBAGE CATERPILLARS IN FLORIDA AND GEORGIA, USA USING VISUAL DAMAGE THRESHOLDS.

Workman, R. B., Chalfant, R. B., and Schuster, D. J.

Cabbage was sprayed with different insecticides according to different management schedules and visual damage thresholds during two growing seasons. A visual damage threshold of 1-2 holes/plant was as effective as larval counts for making treatment decisions and was less time consuming. Worm damage before head leaves formed did not affect marketability the first season but did the second season. Numbers of sprays were reduced both seasons by using visual damage thresholds over regular treatments with a loss in % marketable heads the second season but not the first

13R-5,17 MANAGEMENT OF RED SCALE (*AONIDIELLA AURANTII*) ON CITRUS IN SOUTH AFRICA.

Giliomee, J.H. (Dept. Ent., Stellenbosch Univ., Stellenbosch, 7600 South Africa)

Various strategies are presently applied in South Africa for the control of red scale on citrus. Organophosphate insecticides such as parathion and methidathion can be used effectively as an early preventative treatment except where OP-resistance has been recorded. These insecticides are detrimental to an efficient natural enemy complex, consisting of various local and exotic hymenopteran and coccinellid species, attacking different host stages. Alternatively mineral oils are used as a late preventative treatment, being less harmful against natural enemies and giving control against resistant scale. The no-treatment alternative may result in scale moving to the fruit if not adequately controlled by natural enemies; they can be removed in the orchard by a mixture of dimethoate and omethoate or in the packhouse by a descaling machine. The effectiveness of the latter allowed the economic threshold for red scale to be changed from a small number of scale on the fruit to the higher level that causes damage to the tree. An experimental insect growth regulator was effective against juvenile red scale and had no direct effect on their natural enemies. Control measures with little effect on red scale natural enemies are available for other citrus pests. As a result IPM is successfully practiced at large estates.

13R-5,18 SCALE INSECTS /HOMOPTERA:COCCOIDEA/ ON FRUIT TREES AND THEIR PARASITES IN SOUTH-EAST EUROPE.

Kozár,F.,Jasnosh,V.A.,Konstantinova,G.M./Research Institute for Plant Protection,Budapest,Hungary and Tbilisi,USSR;Central Research Institute for Plant Quarantine,Moscow,USSR/

Data of literature and results of a survey in 1976 in Middle- and East-Europe on the distribution of scale insects infesting fruit trees indicated highest number of species /more than 2o/ in some south eastern countries of Europe. The species pattern shows remarkable differences even between two neighbouring countries, e.g.Georgia and Turkey.Parlatoria theae,Leucaspis japonica,Ceroplastes japonica were found only in Georgia.Nilotaspis halli,Quadraspidiotus lenticularis,Q.marani,Suturaspis archangelskayae,P.oleae,Lepidosaphes ulmi,Parthenolecanium corni,Sphaerolecanium prunastri occured only or in much higher densities in Turkey.

13R-5,19 PRESENT STATUS AND FUTURE PROSPECTS OF PEST MANAGEMENT FOR APPLE IN INDIA.

Verma, A.K., Bhalla, O.P., Dhaliwal, H.S. (Dept.Ent.-Api., HPKVV, Solan, India 173 213)

Recent intensification of apple growing in India has brought in its vein a number of pest problems of which San Jose scale, woolly apple aphid and blossom thrips are important. Fortunately the crop has been free from the attack of some serious pests found in other parts of the world and therefore, apple growers in India are using relatively lesser amounts of toxic chemicals which in itself is an indication of a healthy trend towards managing pests of this crop. This paper gives an account of the pest control measures in vogue in the country and points out lack of basic bio-ecological data necessary for the development of a sound pest management programme, and also the shortcomings of a predominently chemical approach adopted so far. Need for a change in the orientation of future research directed towards improvements in the horticultural practices, crop loss assessment and the pest complex associated with it, economic thresholds of important pests, and the use of bioenvironmental monitoring in forecasting pest outbreaks, is stressed. Future prospects of evolving an integrated pest management strategy suiting the socio-economic conditions of the apple growers are suggested.

13R-5,20 USE OF ENTOMOPHAGOUS COCCINELLIDS IN PEST APHID MANAGEMENT

Hodek I. and Iperti G. (Inst. Ent., Czechosl. Acad. Sci., Prague 12800, Czechoslov.)

Spectacular successes can be achieved only in specific cases of biological control, usually by introducing coccinellids against coccids in subtropical regions. A recent example is the introduction of the Iranian population of Chilocorus bipustulatus to Mauretania against Parlatoria blanchardi. Although less spectacular, the importance of aphidophagous and acarophagous coccinellids was demonstrated by experiments or by chemical control. If-in the framework of integrated control in orchards- the use of pesticides is limited enough and selective compounds are used at an appropriate time, the regulatory activity of coccinellids can be restored. Laboratory mass rearing for periodic release has recently been undertaken, e.g. with Coccinella septempunctata in Maine, U.S.A. and Semiadalia undecimnotata and Adalia bipunctata at Antibes, France. To decrease the price of mass reared coccinellids, artificial foods or alternative hosts are searched for ; best results were achieved by Japanese workers, particularly with Harmonia axyridis.

13R-6,21 CONTROL THRESHOLD FOR THE RICE LEAF BEETLE (OULEMA ORYZAE) AND REQUIRED SAMPLE SIZE.

K. Emura and Kojima A. (Niigata Pref. Agr. Expt. Sta., Nagaoka 940 Japan)

The best time for insecticidal control of the rice leaf beetle, Oulema oryzae, is when hatching is at its peak or about 4-5 days after the peak oviposition. On the basis of the relationship between the damage caused by the 3rd and 4th inster larvae and the survival rate from egg to the 3rd inster, the control threshold as determined at the peak egg density was about 8 eggs per hill. The control threshold in terms of the peak density of immigrated adults in the paddy field was estimated at about 0.1 adults per hill. The right time of insecticide application normally comes after 10 days of peak adult density. The practical sample sizes reqired for decision making of insecticide application were estimated at 36 hills (18 points X 2 hills) and 100 hills (4 points x 25 hills) per paddy field, for egg masses and adults, respectively.

13R-6,22

PEAR PSYLLA: RELATIONSHIP OF EARLY SEASON NYMPHAL DENSITIES TO FRUIT DAMAGE ON THREE WINTER PEAR VARIETIES.

Westigard, P. H. (Ore. State Univ., So. Ore. Experimemt Station, Medford, Ore. 97502)

The pear psylla, *Psylla pyricola* Foerster, is a key pest in North American pear orchards. To avoid the use of unwarrented control effects, knowledge is needed of the relationship between pest density and damage potential. Tests were conducted from prebloom period through June in 1978 and 1979 on the relationship of pear psylla nymphal densities and fruit damage with marked differences noted between varieties. The most susceptable fruit to psylla honeydew damage was the D'Anjou followed by Comice and finally the Bosc cultivars.

13R-6,23

THE DAMAGE THRESHOLD AND ECONOMIC INJURY LEVEL OF THE COTTON LEAFWORM, *SPODOPTERA LITTORALIS* (BOISD.) IN COTTON FIELDS.

Hosny, M.M, Iss-hak, R.R. and Foda, M.E. (Plant Protection Dept., Faculty of Agriculture, Ain Shams University, Shoubra El-Kheima, Cairo, EGYPT).

By applying artificial infestation of the cotton leafworm eggmasses, the economic damage threshold was found to be 4000 eggmasses per acre. This means, from the "applied" point of view, that once the total number of eggmasses collected from "representative" cotton fields, in a certain area, reaches the 4000 mark, irrespective of the period which that number has taken to accumulate, chemical control measures will have to be applied to check the damage and keep it from reaching the economic injury level. The latter lies somewhere between 4000 and 4400 eggmasses per acre. It is worthy of mentioning, however, that the annual infestation hardly reaches that threshold in more than 20% of the cotton growing area in Egypt, especially in "normal infestation" years.

13R-6,24

ECONOMIC THRESHOLD STUDIES OF THE CORN ARMYWORM, *MYTHIMNA SEPARATA* WALKER IN CORN AND SORGHUM VARIETIES.

Charoenying, S.(Dept. Ent., Kasetsart Univ., Bangkok, Thailand

Field cage experiments were carried out to study the effects of the corn armyworm, *Mythimna separata* Walker in corn-Suwan-1, Supersweet and sorghum-KU-257. Five rates of first instar *Mythimna separata* larvae ranging from 0, 2, 4, 8, and 16 larvae per plant, were liberated on caged corn and sorghum varieties. Infestation periods were designated as whorl and tassel stages of corn. Results of the studies show that tassel stage was the most damaging. Supersweet receives more significant damage than sorghom-KU-257 and corn-Suwan-1. Infestation rate of 26,666 larvae per acre was found to be above the economic injury level for corn-Suwan-1, Supersweet and soeghum-KU-257.

13R-7,25 DEVELOPMENT OF EXTENSION INTEGRATED PEST MANAGEMENT PROGRAMS IN THE UNITED STATES OF AMERICA.

Edwards, R. and Blair, B. (Dept. Ent., Purdue Univ., W. Lafayette, Indiana, 47907, USA)

Dwight Isely, University of Arkansas, developed a boll weevil pest management system utilizing scouting in the 1920's. In 1925 he placed students with farmers to scout their cotton, with farmers paying for the service. Widespread adoption did not occur because of an inadequate information delivery system.

Major problems from the late 20's until late 60's that retarded growth of IPM were no widespread environmental concerns, lack of insecticide resistance problems, inexpensive and readily available insecticides and lack of adequate money for IPM program development.

The first two extension IPM pilot programs were established in 1971 to control insects on tobacco and cotton. Subsequently, in 1979 programs have expanded into 50 states and 2 protectorates on approximately 45 commodities. Depending on the type of local agriculture, crops involved, and pest complexes, the crop acreage varies from 13 acres involving 3 apple growers in Vermont to 295,000 acres of cotton in Alabama. This variation reflects the acres in a given state and how long the state has been developing an IPM program. The development of pilot programs has progressed from simple to complex systems. The first programs involved only management of insects, whereas many established programs manage complex communities of pests.

Since 1972, extension IPM programs have been conducted by the Cooperative Extension Service. Guidelines are periodically reviewed and approved by the Extension Committee on Policy. The guidelines require that (1) guidance be provided by an interdisciplinary steering committee; (2) local committees carry out programs; (3) growers pay cost of scouting; and (4) states submit an annual plan of work, budget and progress report.

13R-7,26 INTEGRATED CONTROL OF RESSELIELLA THEOBALDI (DIPTERA; CECIDOMYIIDAE) AND MIDGE BLIGHT IN RED RASPBERRY (RUBUS IDAEUS).

Woodford, J. A. T., Williamson, B., Lawson, H.M. and Gordon, S.C. (Scottish Horticultural Research Institute, Invergowrie, Dundee, Scotland, U.K.

The raspberry cane midge, *Resseliella theobaldi*, became a serious pest of raspberry production in Scotland in the mid 1970s. Larvae feeding in splits on first year canes predispose the canes to invasion by fungi which block the vascular cylinder resulting in partial or complete death of overwintering canes before they can bear fruit the following year (midge blight). Insecticidal control is difficult because of the prolonged emergence of overwintered first generation *R. theobaldi* and because dense cane growth prevents the passage of spray machinery (generation 2). An alternative successful control was achieved by removing the first flush of young cane in the spring with the contact herbicide dinoseb. The replacement canes which subsequently grew provided fewer oviposition sites (natural splits) than the original young canes. The incidence of *R. theobaldi* and midge blight was substantially reduced. Yields were increased by 35% in the first year because of reduced competition between vegetative and fruiting canes and by 40% the following year because of decreased disease incidence.

13R-7,27 INTEGRATED CONTROL OF INSECT PESTS ON IRISH POTATOES FOR SEED PRODUCTION IN KYUSHU, JAPAN.

Inoue, H. (Aino Potato Branch, Nagasaki Agric. & Forest. Expt. Sta., Aino, Nagasaki, 854-03 Japan)

Potatoes are cropped twice a year. Experiments were conducted at Aino, Nagasaki, for 1977 to 1979, using *Tachibana*, one of popular cultivars, moderately resistant to mosaic (PVY) and susceptible to leafroll. In spring crop, two aphid-borne virus diseases; mosaic and leafroll, *Mamestra brassicae* (Lep., Noctuidae), and *Henosepilachna vigintioctopunctata* (Col., Coccinellidae) are serious. Mosaic was suppressed on early-planted potatoes by mulching with polyethylene film, whereas leafroll was not sufficiently prevented by this method. Acephate (50 WP; 0.33 kg a.i./ha) treated once /spring crop was enough for suppressing leafroll and other insect pests, when potatoes were cropped early by mulching. Yields were higher under early-planting by mulching than under ordinary-planting. The seed tubers produced from early-planted potatoes sprouted healthily well for fall crop.

In fall crop, *M. brassicae*, *Spodoptera litura* (Lep., Noctuidae), *Gnorinoschema operculella* (Lep., Gelechiidae), and leafroll are important as pests. Acephate should be sprayed twice /fall crop in practice to reduce the damage caused by insect pests and leafroll.

13R-7,28 COMMERCIAL TRAPPING SYSTEMS FOR THE JAPANESE BEETLE (*POPILLIA JAPONICA*).

Klein, M. (USDA, OARDC, Wooster, Ohio 44691, USA)

Three companies were involved in marketing trapping systems for the Japanese beetle in the Eastern U.S.in 1979. Two firms used a metal trap with a 7:3 mixture of phenethyl propionate (PEP) and eugenol mixed with bran as the bait. The remaining firm's trap consisted of plastic components and PEP: eugenol dispensed from filter paper in a lure pack. The plastic traps utilized the synthetic female sex pheromone, (Z)-5-(1 Decenyl dihydro-2 (3H)-furanone, as an additional lure component and dispensed it with multilayerer Hercon $^{(R)}$ tape. Captures of beetles in the plastic traps were about double those in the metal traps during a 6 week testing period. Placement of the sex pheromone in the metal traps with the bran lure increased captures about 8 fold early in the season and 3 fold for the whole season over similar traps without the pheromone. Availability of lures and interest in trapping has stimulated many people to fabricate homemade traps for Japanese beetle.

13P,1 Formulation of the Synthetic Sex Pheromones and Traps for Monitoring and Mass-Trapping

Sato,Y. and Kumazaki,Y(Pesticide Research Laboratories,Takeda Chemicals Industries,Ltd.,Kyoto,606 Japan)

For the practical application of the synthetic sex pheromones of *Spodoptera litura*, *S. littoralis* *Adoxophyes orana*, *A. fasiata*, *Carposina niponensis*, *Leucania separata*, *L. loreyi*, *Plutella maculipennis*, *Synthanthedon hector*, *S. tenuis*, *Graphorith molesta* and *Acrolepia alliella*, these synthetic compounds were dissolved in hexane and absorbed in the natural rubber caps with antioxidant.

In the formulation(Pherodin SL) of a rubber cap containing 4.55mg of (Z,E)-9,II-tetradecenyl acetate(I) and 0.45mg of (Z,E)-9,12-tetradecenyl acetate(II), the attractiveness to the male moths of *S. litura* persisted constantly two months in the dasheen,the sweet potato and the soybeen fields.

In the case of a rubber cap containing 5mg of (Z)-7-eicosen-11-one(III), the attractiveness to the male moths of *C. niponensis* persisted for more than three months in the apple and peach orchards. On the other hand, the amount of compound I and II in the caps used for the trapping tests decresed similarly with time and reduced to about 40% of initial amounts during two months in summer season. The amount of compound III in the caps remained 70% ever after three months. The results of the trapping tests and the quantitative analysis indicated that the natural rubber caps without sulfur have a good property as keeper of the sex pheromones.

Three types of a sticky, a water-bath and a dry trap for capturing males were designed and evaluated trapping efficiency. In conclusion, the dry traps were suitable for monitoring and mass-trapping of *S. litura* because no supply of water or sticky materials are necssary.

13P,2 STICKY-SUCTION TRAP FOR SEQUENTIAL RECORDS OF NATURAL ENEMIES AND PESTS.

TAKAGI, K. (Kuchinotsu Branch, Fruit Tree Research Station, Kuchinotsu, Nagasaki 859-25, Japan)

Sticky-suction trap successfully monitored the natural enemies and pests in tea field and citrus orchard during 1974-1979.

The seasonal abundances obtained in tea field was as follows. 1) Three species of parasites, *Arrhenophagus albitibiae, Tomsonisca typica, Archenomus bicolor* and males of their host scale (*Pseudaulacaspis pentagona*). 2) Three Braconidae parasite, *Ascogaster reticuratus, Apanteles adoxophyesi, Bracon adoxophyesi* parasitizes smaller tea tortrix. 3) Mymaridae parasite(*Anagrus sp.*) of tea green leaf hopper.

The results of 2 years of seasonal monitoring in citrus orchard was as follows. 1) The analysis of the dispersal and propagation of *Aphytis lingnanensis* released to control for arrow head scale(*Unaspis yanonensis*) and number of males of the scale. 2) The seasonal trend of egg parasite(*Megaphragma sp.*) and its host(*Scirtothrips dorsalis*). 3) The synchronization of egg parasite(*Inostemma sp.*) attack flower-bud midge and its host. 4) Four species of predators of citrus red mite, *Stethorus japonicus, Oligota sp. Scorothrips sp.* and *Haplothrips sp.*

These records could be used for the evaluation of parasites and predators in fields and pest management program.

13P,3

FORECASTING OCCURRENCE OF PEST INSECTS WITH PLANT-PHENOPHASE INDICATORS: EMERGENCE PATTERNS OF AGROMYZA FRONTELLA (RONDANI) (AGROMYZIDAE:DIPTERA)

Alicandro, Alfred J. and T. Michael Peters (Dept.Ent. Univ.Mass. Amherst,Mass. 01003, U.S.A.)

During three consecutive seasons, the flowering stages of selected non-host plants were evaluated for reliability as indicators of adult Alfalfa Blotch Leafminer emergences. Spring emergence from overwintering pupae (5-11-78; 4-31-79) was closely correlated to beginning of bloom of pin cherry, Prunus pennsylvanica (5-12-78; 4-30-79). Similar correlations are presented for subsequent emergences.

13P,4

The system of integrated struggle with cotton vermins.

Kovalenkov V.G. Tajik Research Institute for Agriculture, Dushanbe, USSR.

Cotton in Tajikistan is spoiled by Tetranychus telarius, Chloridea obsoleta, Agrotis Sigetum, Laphygma exigua, Aphis gossypii, A.crossivora, Acyrthosiphon gossypii. The attempt to solve the problem of struggling with them by numerous chemical treatments has led to resistivity, biosphere pollution, entomophag destroying. The efficiency of integrated system with integrated application of pesticises in combination with biological, agrotechnical, organisational-economic means has been proved by investigations. Treatment with pesticides is allowed against Chloridea obsoleta in discovering 10-12 caterpillars per 100 medium - fibre cotton plants and 3-5 - fine-fibre ones, against Tetranuchus telarius - with the population in 10% plants. With limited pesticides application the season colonisation of Trichogramma genus and Habrobracon hebetor. Say parasite, application of entomocide preparation on the basis of Bacillus thuringiensis var, dendrolimus provided long-time control of harmful species populations and improving of the environment. Agrobiological principles of the integrated system are applied in Tajikistan over 250 thousand hectares. During the decade the application of pesticides in cotton growing has been reduced thrice. The efficiency of plant protection has been increased by 35-40%, the cotton yield by 3-5 centners per hectare. It became possible to abolish treatments over the area of 50-70 thousand hectares.

13P,5

Pests and diseases control system on potatoes in Lithuania SSR.

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Dotnuva-Akademia, Lithuanian research institute of agriculture

Lithuania SSR is in region where cool, moist weather favours both potato production and his diseases and pests. The main losses of potato yield is caused by pests: colorado potato beetle, cutworms, afids as vectors of virus diseases and diseases: late blight, blackleg, common scab, virus diseases. Potencial losses reach 50% and more. To prevent them is necessary to use in potato fields more pesticides as in other field crops (15-20 kg per hectare against 4 kg per hectare). In Lithuania research institute of agriculture is carried out complex system of protection potatoes fields from pests and diseases with minimal use of pesticides. It includes cultural methods, the usage of resistant varieties and usage of pesticides only when it is economically necessary.

13P,6 SOME QUESTIONS OF INTEGRATED CONTROL OF FRUIT TREES IN GEORGIA

ALEKSIDZE G.N., GEORGIAN PLANT PROTECTION RESEARCJ OMSTOTITE,
TBILISI

the main distructive insects and mites attacking fruit trees are the subjects of exploration with what indicated the great useful role of natural enemies, which number by heaviest spray applications of nonselective pesticides becomes evidently less. Studying the main bioecological questions on population dynamics as well as influence of pesticides againsts pests and their natural enemies gave the possibilities to the author to compile the integrated control including: to apply selective aphicide and acaricide and predators and parasites against aphids and mites; bacterial preparations against leaf chewing insects; relative unenocuous pesticides and pheromones against moths. At present the above mentioned measures are beeing successfully applied in the orchards.

13P,7 INTEGRATED PEST MANAGEMENT FOR CAULIFLOWER SEED CROP.

Bhalla, O.P., Dhaliwal, H.S. and Verma, A.K. (Dept.Ent.-Api., HPKVV, Solan, India 173 213)

This paper presents an account of the development of pest management programme initiated in 1976-77 for seed cauliflower. Of over a dozen injurious insect species, Brevicoryne brassicae, Pieris brassicae, Plutella xylostella and Bagrada cruciferarum are the major pests. B. brassicae has been identified as the key pest and, therefore, the overall management strategy is predominently aphid oriented. Seasonal population trends highlight the period from transplanting in October to mid February as a period of no or low incidence when the caterpillars and the painted bug are in winter diapause and low temperatures do not allow population build up of the cabbage aphid. The highest incidence of the aphid is from mid February to April but for the cabbage caterpillar and the diamondback moth it is from March to April and for the painted bug from April till harvest in May. On the basis of above observations and the findings that (i) except the cabbage aphid, the remaining species complete only a single generation on seed cauliflower, and (ii) the biotic control agents are ineffective due to their late appearance, a pest management programme was devised consisting of (a) removal and destruction of egg masses and caterpillars during March (b) side dressing with phorate (thimet) granules @ 1.5 a.i./ha in middle of March or alternatively two applications with methyl demeton @ 175 ml a.i./ha depending on the aphid population and (c) foliar application of endosulfan @ 375 ml a.i./ha in April against the caterpillars and the painted bug. This tentative pest management programme is being tested on private holdings and efforts are underway to bring further refinements.

13P,8 Ecological and physiological connections in the triotroph system; plant-the insect pest-the entomophage and agroecosystem control.

K.E.Voronin, I.D.Shapiro, N.A.Vilkovs, V.A.Shapiro. Leningrad.-Pushkin 6 chaussee Podbelsky 3, VIZR.

Agroecosystem control is the major strategic problem in plant protection. At present, in connection with difficulties in separating of control elements in the agrobiocenosis complex system on the whole it is necessary to attract attention to staged solving of this problem. As a base of agroecosystem we single out the triotroph system; the plant-the phytophagous insect-the entomophage, which is responsible for main streams of substance, energy, and information. Such an approach considerably facilitates out progress on the way of agroecosystem control. Determining the expedience of triotroph studies we are guided by the data from the history of formation and development of interaction for the elements of this system and by the results of analysis of their functional connections. Conducted researches allowed to reveal concrete correlations between the food plant and consumers of the first and the second order, opening real possibilities in management of trinomial link-triotroph in the interests of improving the integrated plant protection.

13P,9 Developing integrated control program of BPH in Indonesia, problems and prospects.

Oka, Ida Nyoman, CRIA MERDEKA 99 BOGOR, INDONESIA

Simplistic ("ad hoc") approaches for preventing BPH epidemics such as the intensive application of pesticides or the planting of narrow genetic based varieties resistant to BPH appear to be inadequate. A number of pesticides cause BPH resurgence, destroy the natural enemies, cause environmental pollution and are hazardous to man. The insect may also develop resistance to the insecticides. The biotype-1 resistant varieties, IR26, IR28, IR30 and IR34, each possessing one dominant gene Bph-1, became susceptible to the newly developed biotype-2 of BPH after only 4 or 5 cropping seasons. Those varieties had to be immediately replaced with IR32, IR36 and IR38 resistant to biotype-2. However, in view of their monogenic resistance (each of them possesses Bph-2 gene) to BPH, they may again trigger development of another biotype capable of breaking down their resistance.

Hence, an integrated BPH control program, found on sound ecological principkes, is being developed to help maintain plant-insect pest interaction well below the economic damage level and thereby minimize its threat to our rice production.

13P,10 RECENT WIDESPREAD OUTBREAKS OF BROWN PLANTHOPPER,NILAPARVATA LUGENS(STAL) (HOM.DELPHACIDE), IN THE TROPICS: CRITICAL COMPARISON OF FOUR EXPLANATIONS. KENMORE, P. (Division of Biological Control,University of California, Berkeley. 1050 San Pablo Ave. Albany, California 94706)

Between 1968 and 1978 massive outbreaks of BPH were newly reported from at least 8 tropical countries. Field work on tropical BPH population ecology revealing good degree of biological control, mostly due to predators, allows the critical comparison of the following four explanations which are often given for the outbreaks: 1)extreme genetic susceptibility of modern,high yield potential rice varieties;2)Increased nutritional quality of modern rice due to high nitrogen application;3)Expansion of irrigation systems and thus the length of the crop growing season;4) Destruction of natural enemies due to misuse of insecticides. All four factors are the result of production intensification programs, and are thus correlated. However,more than 95% of traditional varieties were as susceptible as modern varieties,especially to coevolved BPH populations in the same region;improved nutritional quality has only been shown significant in laboratory studies at nitrogen application levels far above those used by tropical farmers;and no independent mechanism for the role of irrigation has been identified as natural control of BPH populations in each generation is adequate to prevent buildup. Only the insecticide misuse explanation has field experimental and historical support, and thus is the strongest theory. The expanded growing season with irrigation reduces the traditional dry season which formerly decimated pest and natural enemy populations. This may render the tropical rice agroecosystem more reliant on biological control and thus more susceptible to insecticide misuse.

13P,11 LIFE SYSTEM MODEL OF BROWN PLANTHOPPER,NILAPARVATA LUGENS (STAL) (HOM.DELPHACIDAE),POPULATION DYNAMICS FROM TROPICAL FIELD STUDIES IN THE PHILIPPINES. KENMORE,P., CARINO,F., AND DYCK,V.A.(Division of Biological Control, 1050 San Pablo Ave. Albany, California, 94706 USA and Entomology Dept. IRRI PO Box 933 Manila, Philippines)

Observational-census and experimental field studies over four seasons provide a conceptual life system model of tropical BPH population dynamics, incorporating estimates of prey death rates and predator rates of increase. The major features include:1)Steady relatively high immigration through most of the crop season;2)Net realized fecundity about 10% of physiological maximum;3)Steady,high proportion of macropterous adults through most of the growing season;4)Cumulative mortality through immature stages high enough to prevent net population increase (or even replacement) without immigration;5)confirmation of the role of predators (primarily Veliids and spiders) with insecticide-check and physical exclusion experiments; 6)direct density dependence in BPH mortality due to both parasites and predators;7)predator rates of increase dependent on density of prey;8)increased proportion of macropterous adults with very high nymphal density;and9) compensation for genetic susceptibility of rice variety by direct density dependence in natural enemy response. The importance of population regulation through natural enemies implicates insecticidal disruption of natural control as a major factor in the BPH outbreaks of the 1970's in tropical countries.

13P,12

Integrated Management of Apple Pests

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An integrated program of arthropod pest management was initiated in commercial apple orchards in Massachusetts (USA) in 1978. The objectives have been: (a) production of high quality fruit, (b) reduction in pesticide use, and (c) encouragement of grower use of particular selective pesticides which allow buildup of beneficial predators and parasites. The program has been built upon a foundation of intensive weekly sampling of IPM and check blocks for abundance of major fruit and foliar pests and their natural enemies. Sticky coated visual traps have been used to monitor tarnished plant bug, European apple sawfly, and apple maggot fly adults, while sex pheromone traps have been used for codling moth and leafrollers. Fruit or foliage inspections have been used to monitor plum curculio injury, green fruitworm and leafminer larvae, spider mites and mite predators, and aphids and aphid predators. To date, the results have shown substantially higher quality fruit, much less insecticide and miticide usage, and greater numbers of spider mite and aphid predators in the IPM blocks compared with the checks.

13P,13

NEEM SEED OIL, AN ANTIFEEDANT FOR BROWN PLANTHOPPER CONTROL,

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Evaluation of neem (Azadirachta indica A. Juss) seed oil showed potential for control of the brown planthopper, Nilaparvata lugens (Stål), a serious pest of rice in Asia. In choice tests, the hopper avoided rice plants sprayed with emulsified, crude oil. The quantity of food ingested, per female per 24 h, was significantly less on 12% neem oil-treated plants than on untreated ones. For every 1% increase in concentration of the oil, the insect's feeding duration was decreased by 0.93 min/h, at the same time hopper's restlessness increased. The insect's growth and development was retarded by neem oil: only 3-9% of 1st instars reached adult stage on plants sprayed with 3% neem oil while 67-88% of nymphs became adults on untreated plants. All the three biotypes of the insect at IRRI were adversely affected by neem oil. Insect's longevity and fecundity on 100% neem oil-treated plants averaged one-fourth to one-tenth of that on untreated plants. Oviposition was strongly deterred on treated plants, however, hatchability of eggs was not affected.

The incidence of the hopper-transmitted ragged stunt virus disease was significantly less in rice field plots ULV-sprayed with emulsified 12% neem oil (@ 2 l/ha at 20, 40, 60, 80, and 100 days after transplanting) than in control plots. Yield increase of ca. 800 kg/ha in 12% neem oil-treated plots over the control was attributable to the lower incidence of ragged stunt and not hopper infestations, which were low throughout the 1978 dry season crop. Natural enemies of the pest were not affected by neem oil. Neem oil's low cost and effectiveness emphasize its potential in rice insect pest management.

14S-1,1 Relationship between Inhibition of Ca-Mg ATPase by Cyclodiene Insecticides and Increased Synaptic Transmitter Release.

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Heptachlorepoxide(HE), dieldrin, aldrin and other cyclodiene insecticides were found to inhibit synaptic Ca-Mg ATPase. To find the relationship between this inhibition phenomenon and the nerve exitation caused by this group of insecticides, in vitro transmitter release tests were conducted by using isolated rat brain synaptosomes and HE as a representing insecticide. It was found that HE slightly increases the uptake of ^{14}C-glutamate and greately stimulates its release. ^{45}Ca^{++}uptake by the synaptosomes increases at the same time. As a result of ^{45}Ca^{++}binding studies with intrasynaptic components it was concluded that HE decreases Ca^{++}binding by the endoplasmic reticulum which contains high titer of Ca-Mg ATPase, and results in the rise of the intracellular Ca^{++}level.

14S-1,3 MODE OF ACTION OF DDT AND PYRETHROIDS: FROM SYMPTOMATOLOGY TO MOLECULAR MECHANISMS.

Narahashi, T. (Dept. Pharmacol.,Northwestern Univ. Med. Sch., Chicago, IL 60611 USA)

A wealth of information has been accumulated regarding various actions of DDT and pyrethroids on insects and other animals. In order to elucidate the mechanisms of action of these insecticides, it is important to integrate these diversed data to construct a picture. Our recent electrophysiological analyses of the actions of DDT and pyrethroids have revealed their unique interactions with nerve membrane ionic channels, the target site of these insecticides. In this presentation, an overall picture will be constructed to see how the action on the target site accounts for the symptoms of poisoning in animals. The primary action of DDT and pyrethroids is represented by a modification of nerve membrane sodium channels to give rise to very slow opening and closing kinetics. The sodium channel is the site where sodium influx takes place generating an action potential. The modification is induced only in a small population of the channels by a low concentration of the insecticides. This results in an elevation of depolarizing after-potential which in turn triggers repetitive discharges. Such a hyperactivity in nerve membranes causes synaptic and neuromuscular transmission to be disturbed, and the intoxicated animal exhibits symptoms of poisoning characterized by ataxia, loss of coordination and hyperexcitation. Facilitation at synapses and neuromuscular junctions by DDT and pyrethroids is ascribed solely to repetitive discharges in the presynaptic terminals. It should be emphasized that only a slight elevation of depolarizing after-potential is enough to induce repetitive response. This accounts for how a functional modification of a small population of the sodium channels is amplified to cause drastic symptoms of poisoning in the animal. Supported by a NIH grant NS 14143.

14S-1,4 MODE OF ACTION OF CHLORDIMEFORM ON THE NEUROMUSCULAR SYSTEM OF INSECTS.

Yamamoto, D. (Mitsubishi-Kasei Inst. Life Sci.) and Fukami, J. (Inst. Phys. & Chem. Res.)

Microelectrodes were used to study the action of chlordimeform (CDF) on the skeletal and visceral nerve-muscle system of larval insects, *Galleria* and *Tenebrio*. Excitatory postsynaptic currents (EPSCs) recorded from the skeletal muscle of mealworm larvae were reversibly depressed by 8×10^{-4} M CDF. Simultaneous forcal recordings have revealed that the postsynaptic current was substantially depressed but that the presynaptic impulse and the synaptic delay remained essentially unchanged. CDF failed, however, to alter the time course and the voltage dependence of the EPSCs. The quantum content estimated by the failure method was decreased by the application of 8×10^{-4} M CDF. Voltage clamp experiments have shown that the amplitude of the glutamate current and its dependence on the membrane potential were unaffected after treatment with 3×10^{-3} M CDF. Also CDF (3×10^{-3} M) had no effect on the reversal potential of the EPSC and the glutamate current. These findings indicated that the site of action of CDF was on the presynaptic membrane. Experiments made on the foregut muscle of waxmoth larvae have shown that the mechanism whereby the action potential is generated from the excitable membrane was suppressed by a higher concentration (5×10^{-3} M) of CDF. The critical membrane potential was always increased, while in some cases the amplitude and the rate of rise of the spike was reduced. CDF at 5×10^{-3} M had very little effect on the outward rectification and effective membrane resistance of the muscle fibres. Based on the above mentioned results, the possible mechanism of action of chlordimeform on the synaptic and excitable membranes are discussed.

14S-1,5 L-LEUCINE AS A NEUROACTIVE SUBSTANCE AND ITS DERIVATIVES AS A NEW LEAD FOR INSECTICIDES.

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A neuroactive substance was isolated from body fluid of silkworm larvae which had been prostrated with DDT. It increased a spontaneous discharge on the isolated abdominal nerve cord of American cockroach and was identified as L-leucine. L-Leucine-^{3}H was incorporated in vivo into the cockroach nerve cord. The release of radioactivity from the isolated nerve cord was accelerated by both the DDT-treatment and electrical stimulation. Leucine was decarboxylated by an enzyme in the cockroach nerve tissue. The metabolite isoamylamine showed the quicker action on the nerve cord than L-leucine. These findings prompted us to develop a new lead for insecticides by modification of amino acids. Five membered cyclic phosphoramidothionates derived from L-leucine and L-valine showed very interesting insecticidal properties. It appears that the hydrophobic branched alkyl group such as isobutyl and isopropyl may contribute to the interaction with the target. The insecticidal activity was affected also by the exocyclic phosphorus substituent.

14S-2,6 METABOLISM OF CHIRAL ORGANOPHOSPHORUS INSECTICIDES IN RELATION TO SELECTIVE TOXICITY.

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Phosphorothioic acid esters and their related compounds are widely used as insecticides. Some of them contain an asymmetric phosphorus atom in their molecules. The chiral isomers of fonofos, cyanofenphos, EPN and their oxon analogs are resolved. These compounds showed a marked difference in toxicity to insects and mammals between enantiomers. The difference in toxicity is mainly attributable to the difference in anti-acetylcholinesterase activity of the corresponding oxon analogs. Metabolism studies in vitro revealed that the P=S to P=O activation reaction mediated by microsomal mixed function oxidases proceeds with retention of configuration at phosphorus. In addition, metabolism studies in vivo indicated that the amount and persistence of the oxon formed in living organisms is one of the important factors related to the difference in toxicity exhibited by the chiral isomers. The delayed neurotoxicity in hens produced by certain chiral thiophosphoryl compounds is likely to be related to the rate of metabolism in the body and the degree of inhibition of neurotoxic esterase in the brain.

14S-2,7 HEPATIC BEHAVIOR OF ORGANOPHOSPHORUS INSECTICIDES AS A DETERMINANT OF THEIR METABOLISM.

Nakatsugawa, Tsutomu (Dept. Env. & For. Biol., SUNY Coll. Env. Sci. & For., Syracuse, NY 13210 USA)

The capacity of a mammal to metabolize and tolerate an insecticide often reflects the titers of various enzymes of biotransformation mainly in the liver. However, total enzymes are not always involved in the metabolism in vivo especially at low doses. Therefore, defining actual fraction of the total titer of each enzyme is critical in the assessment of various side effects by sublethal doses of insecticides. A major, yet so far unexplored, element governing the enzyme action in vivo is the differential exposure of subpopulations of hepatocytes to a toxicant dose. This results inherently from structural features of the liver and distribution characteristics of the toxicant. Metabolism of parathion and related organosphosphorus insecticides in vivo and in vitro was examined by using male rats, cell-free homogenates and subcellular fractions, isolated hepatocytes. Rapid absorption of these chemicals by isolated hepatocytes predicted chromatographic behavior of the insecticides within the liver. Liver perfusion experiments verified this. The implications of the finding in understanding the metabolism in vivo will be discussed.

14S-2,8 THE ROLE OF GLUTATHIONE S-TRANSFERASES IN PESTICIDE METABOLISM.

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Various pesticides undergo biological alterations that are catalyzed by a group of enzymes referred to as glutathione S-transferases. Two types of reactions occur. They involve addition or substitution of reduced glutathione with the pesticide. The various type of reactions with different pesticides will be discussed with emphasis on the role that glutathione S-transferases plays in detoxication, selective toxicity, and resistance.

14S-2,9 PYRETHROID METABOLISM IN RELATION TO POTENCY AND SAFETY.

Casida, John E. (Pestic. Chem. Tox. Lab., Dept. Entomol. Sci., Wellman Hall, Univ. California, Berkeley, California 94720, USA).

Pyrethrin I and the early pyrethroids (allethrin, tetramethrin, resmethrin and phenothrin) are chrysanthemates used as knockdown agents and insecticides when residual stability is not required. The synergist piperonyl butoxide is added to some chrysanthemates to increase their potency by inhibiting oxidative detoxification in insects. Permethrin, cypermethrin, decamethrin and fenvalerate with enhanced photostability of both their acid and alcohol moieties are important crop protection agents of long residual action. The structural modifications for photostabilization generally decrease their metabolism rates, thereby increasing insecticidal activity and overcoming the requirement for a synergist. Although halogen substituents are important for stabilization, these insecticides retain oxidatively-susceptible methyl and phenyl sites and an enzymatically-labile ester group. Metabolic attack at multiple sites including conjugation yields numerous metabolites, e.g. more than 40 identified metabolites of cis- and trans-permethrin in insects. Detoxification may contribute to resistance in some insect strains but it is often a minor factor relative to nerve insensitivity. Rapid metabolism in mammals is an important safety feature.

14S-2,10 METABOLISM OF HEXACHLOROCYCLOHEXANE AND RELATED COMPOUNDS,

Kurihara, N., Tanaka, K., and Nakajima, M. (Radioisotope Res. Ctr., Kyoto Univ., Kyoto 606, Japan)

Lindane (γ-isomer of hexachlorocyclohexane) is dehydrogenated, dehydrochlorinated and oxygenated in the first step of its detoxicating biodegradation in mammals and in insects. Reductive dechlorination is observed with rat liver microsomes, but the dechlorination activity of house fly seems very low. Glutathione conjugation is also an important detoxication reaction. In the rat, various intermediates for conjugates are present, whereas, in the house fly, conjugation occurs on few pentachlorocyclohexenes. Other hexachlorocyclohexane isomers are similarly metabolized, but their pathways are simpler. Isolated rat liver cells are proved to be a good system for metabolism studies of these compounds and other pesticides.

14S-3,11 RESISTANCE OF RICE INSECT PESTS TO INSECTICIDES IN JAPAN.

Ozaki, K. (Fuchu Branch, Kagawa Agricultural Experiment Station, Sakaide, 762 Japan)

Since 1961 when parathion resistance of the rice stem borer, *Chilo suppressalis* had appeared, the number of species of rice insect pests which have developed resistant strains has increased in Japan as shown in Table 1.

Table 1.

Pest species	Insecticides developed resistance	Areas
Chilo suppressalis	BHC and organophosphorus (OP) insecticides	Chugoku and Shikoku districts
Nephotettix cincticeps	OP and carbamate insecticides	Kanto, Tokai, Kinki, Chugoku, Shikoku and Kyushu districts
Laodelphax striatellus	BHC and OP insecticides	Chugoku and Shikoku districts
Nilaparvata lugens	BHC and OP insecticides	Chugoku, Shikoku and Kyushu districts
Oulema oryzae	BHC	Hokkaido district
Hydrellia goiscala	BHC	Hokkaido district

The resistance of rice insect pests to insecticides is indicated to be derived from successive exposure to the same or same types of insecticides in the field. It was found that highly efficent suppression of resistance developement in the insect pests can be achieved by mixtures of OP and carbamate insecticides that have synergistic insecticidal activity against strains resistant to the individal insecticides in the mixture. At the present time, mixtures of diazinon, propaphos or Ofunak with carbamates are practical insecticides for the control of the leaf- and planthopper in many parts of Japan.

14S-3,12 INSECTICIDE RESISTANCE IN PYRALID MOTHS INFESTING GRAIN AND STORED PRODUCTS.

Attia, F.I. (B.C.R.I., Dept. Agric., P.M.B. 10, Rydalmere, N.S.W., 2116, Australia)

Larvae of *Plodia interpunctella* (Hubner), *Ephestia cautella* (Walker) and *E. kuehniella* Zeller can cause significant damage to grain and stored products. Organochlorine (OC), organophosphorus (OP) and pyrethroid insecticides have been used to control these pests. Surveillance testing has established a wide distribution of resistance to OC and OP insecticides in larvae of each of these species. As yet, pyrethroid resistance has not been diagnosed in any of the species.

Genetic enquiry into DDT, dieldrin and malathion resistances (which are separate entities) in *P. interpunctella* suggests that each resistance is due to a semi-dominant resistance allele.

Synergism studies using triphenyl phosphate (TPP), piperonyl butoxide (Pb) and S,S,S-tributyl phosphorothioate (DEF) suggest that hydrolases and mixed function oxidase systems are largely responsible for OP resistance in *P. interpunctella*. The above synergists failed to synergise OC chemicals.

14S-3,13 INTRODUCTION OF THE ACARICIDE RESISTANCE OF MITE IN JAPANESE TEA PLANTATION,

Osakabe, M. (Morioka Branch, Fruit Tree Res. Stn. M.A.F.F., Morioka, 020-01, Japan

The Kanzawa spider mite is the major pest of tea plant in Japan. Acaricide resistance of this mite in tea field was observed since 1961. Presently, the resistant mites to OP compounds were widely distributed in Japanese tea producing prefectures, and also the mites of multiple resistance to OP compounds and Dicofol were observed in some prefectures.

Inheritance of mites resistant to Estox was dominant, but resistance to Dicofol was recessive. On the other hand, the mites resistant to Estox for about two years under the non-spraying condition at 25 C did not show larger difference on the resistivity than that of former population, but the Dicofol resistivity of mites reared for about four months under same condition reduced remarkably. From these facts, it was thought that the inheritance of mites resistant to Estox might operate on the development and maintenance of resistivities of mites to Estox, but the genetic properties of mites resistant to Dicofol might probably participate in the decrease of resistivities of mites to Dicofol in the field.

14S-3,40 IMPACTS OF INSECTICIDE RESISTANCE ON CROP PROTECTION ENTOMOLOGY.

Glass, E. H. (Dept. Ent. Cornell Univ., Geneva, N.Y., USA) and Reynolds, H. T. (Univ. California, Riverside, CA, USA)

The selection of insect strains resistant to insecticides has had a profound impact on crop protection and the profession of entomology. Control programs based on insecticides frequently must be modified as insects become resistant. In some instances effective substitute chemicals or alternative controls have not been available and disastrous crop losses have occurred. Resistance decreases the useful life of many insecticides and miticides, has limited the development of analogs of already developed materials and seriously reduced the range of effective insecticides.

The problems of resistance have spurred entomologists to seek new approaches to crop protection. Emphasis has been given approaches such as the development and use of behavior modifying chemicals and insect hormones. Reemphasis of the ecological basis for crop protection has occurred. The problems associated with resistance have provided the major impetus for the development of integrated pest management programs. These and other aspects are discussed.

14S-3,14 INSECTICIDE RESISTANCE IN MEDICAL INSECTS.PROBLEMS,PROSPECTS AND STRATEGIES. I. INTRODUCTION AND HOUSEFLIES.

Keiding, J.(Dan.Pest Inf.Lab.,28oo Lyngby,Denmark)

Practical problems connected with resistance include failing effect of established insecticides, cross-resistance, high price of substitute insecticides, and development of resistance due to agricultural use of insecticides.
Scientific problems include the factors influencing the development and stability of resistance, and the genetical basis of resistance and cross-resistance.
The prospects are that the practical problems will accelerate unless sound strategies are put to use.
The strategies may include systematic monitoring of resistance and screening of substitute insecticides, and/or control systems to avoid or reduce development of resistance by reduction of selection pressure and by optimal sequence and distribution in the use of insecticides.
Houseflies: Recent global development of resistance (since 1976) is reviewed. Multi-OP-resistance has further increased as to areas and levels, with or without cross-resistance to carbamates, and pyrethroid-resistance (pyr-R) has rapidly developed in some areas where residual pyrethroids were used. However, the potential for pyr-R differs from area to area, e.g. correlated with the occurrence of the DDT-R-gene kdr. Where kdr is common, residual pyrethroids should not be used. This and other examples of how the experience from housefly populations may be used for strategies in other insects, are discussed.

14S-3,15 ORGANOPHOSPHATE-RESISTANT HOUSEFLIES IN JAPAN AND THEIR MECHANISM OF RESISTANCE.

Shono, T. (Dept.Med.Zool.,Univ.Occupational & Environmental Health,KITAKYUSHU,807 JAPAN)

Since the first report on diazinon resistant housefly in Hokota (Yasutomi,1961), the development of resistance to OP-insecticides has been observed in various field populations of the housefly in Japan (e.g., Hayashi *et al.*,1979). The housefly population of Yumenoshima, dumping islands in the Tokyo Bay, has developed high multiresistance to OP-insecticides after successive field selections and continuous immigrations of resistant genes from Metropolitan Tokyo. The resistance ratios (Yumenoshima/SRS) to malathion, fenitrothion and diazinon are 982, 2,224 and 1,042, respectively (Yasutomi & Shudo,1978). The mechanisms of resistance in the Hokota strain are high activities of mixed function oxidases and phosphatase, and slow penetration (Shono,1974). In addition to the these mechanisms, Yumenoshima population has high activities of carboxyesterase and GSH-transferase, and altered ChE, as the mechanisms of OP-resistance (Niwa *et al.*,1977; Shono,unpublished). Hiroyoshi & Fukumori (1977) demonstrated the sex-determination for the most resistant populations in Japan was charaterized by autosomal mechanism instead of normal XY-type.

14S-3,16

THE INSECTICIDE RESISTANCE OF MOSQUITOES IN CHINA, Liu Wi-teh, Chen Chiao-yun, Tang Chen-hua and Zhang Zhao-yuan (Shanghai Institute of Entomology, Academia Sinica, Shanghai, People's Republic of China).

The tolerance to OPs of larvae of Culex pipiens pallens have been surveyed in nearly 20 cities. The specimens collected from east China showed resistance but from the west China something was susceptible. The adult of Anopheles sinensis Wied. showed high resistance to both of DDT and BHC. After 1973, the resistance level to BHC showed rather in the decrease, but developed resistance to OPs in some districts.

A strain of Culex pipiens pallens collected from Shanghai was exposing with Dipterex over 80 generations. The resistant spectra, synergists and biochemical mechanism of this strain have been studied. The results showed that carboxylesterase plays an important role in mechanism of OP-resistance in this mosquitoes.

A strain of Anopheles sinensis collected from Shanghai has also been exposing with malathion over 30 generations. The resistant spectra seem rather narrower than the Dipterex resistance.

14S-4,18

RESISTANCE MECHANISMS IN THE CATTLE TICK BOOPHILUS MICROPLUS TO ACARICIDES. Roulston, W.J. and Nolan, J. (CSIRO, Long Pocket Laboratories, Indooroopilly, 4068. Australia.

The cattle tick has over the last fifty years developed resistances to a wide range of acaricides. Studies have been made on strains resistant to arsenic, BHC-toxaphene-dieldrin, DDT, organophosphorus compounds, amidines and synthetic pyrethroids. The complexity of these resistances is indicated by the characterization of nine different organophosphorus resistant strains. It is also apparent that there is more than one type of resistance to synthetic pyrethroids.

Resistance mechanisms have been found to include increased detoxication, altered sensitivity of the target site and a combination of these two mechanisms.

14S-4,19

SYNERGISTIC ACTION OF MALATHION OR PHENTHOATE WITH ORGANOPHOSPHATES(OP), CARBAMATES AND SYNTHETIC SYNERGISTS AGAINST OP-RESISTANT KANZAWA SPIDER MITE. KUWAHARA,M.(DIV. ENT.,NATION. INST. AGRIC. SCIEN., TOKYO 114, Japan)

Combination of malathion or phenthoate with OP, carbamate and synthetic synergist showed synergism against OP-resistant mite. K-1, one of the saligenin cyclic phosphorus esters, showed high synergism with malathion but not with phenthoate. Six esterase bands were separated by agar gel electrophoretic method, and they were dissected and incubated with ^{14}C-malathion. Malathion was decomposed mainly by E_3 and E_4 band, and these bands were deactivated completely by 5×10^{-4}M K-1.

14S-4,20

THE ROLE OF THE CARBOXYLESTERASE E-4 IN THE RESISTANCE OF MYZUS PERSICAE TO INSECTICIDES. Devonshire, A.L. and Sawicki, R.M. (Insecticides and Fungicides Department, Rothamsted Experimental Station, Harpenden, Herts., U.K.)

Of several esterases in homogenates of susceptible (S) and insecticide-resistant (R) peach-potato aphids (Myzus persicae) only one, E-4, hydrolyses insecticidal esters including organophosphates, carbamates and pyrethroids. R aphids have more E-4 than S insects and therefore detoxify insecticides faster. Because hydrolysis rates differ, resistance is generally weakest to carbamates, moderate to organophosphates and strongest to pyrethroids. We have identified seven variants with increasing resistance caused by the doubling of E-4 between each variant (from 2^0 to 2^6) implying structural duplication in the increased production of the enzyme. The two most resistant variants are usually unstable, and in the absence of selection with insecticides lose resistance and strong esterase activity either in a single step or over several generations. However such reverted aphids readily recover resistance and esterase activity on selecting with insecticides.

With 1-naphthyl acetate as substrate, E-4 from single aphids can be measured readily either in the whole homogenate, or after separation from other esterases by electrophoresis. These procedures monitor rapidly and accurately the level of resistance, and the proportion of the different variants in field populations.

14S-4,21

MECHANISM OF JOINT TOXIC ACTION OF MALATHION AND KITAZIN P® IN THE RESISTANT GREEN RICE LEAFHOPPER. Miyata, T. and Saito, T. (Lab. Appl. Ent. and Nema., Fac. Agr., Nagoya University, Nagoya, 464 Japan)

The green rice leafhopper (*Nephotettix cincticeps* Uhler) is one of the serious rice insect pests snd shows resistance to both organophosphorus and carbamate insecticides. The mixture of certain pesticides is effective to control resistant green rice leafhoppers. A mixture of malathion and Kitazin P® (an organophosphorus fungicide) is also effective to resistant hoppers. High joint toxic action was only observed in the resistant strains, not in susceptible ones. This joint toxic action might be derived from the inhibition of malathiondegrading carboxylesterase by Kitazin P®.

14S-4,22

MECHANISM OF RESISTANCE TO INSECTICIDES IN THE GREEN RICE LEAFHOPPER, NEPHOTETTIX CINCTICEPS UHLER, WITH PARTICULAR REFERENCE TO REDUCED SENSITIVITY OF ACETYLCHOLINESTERASE. Hama, H. (Dept. Ent., Natl. Inst. Agric. Sci., Kanondai, Tsukuba, 305 Japan)

Carbamate-resistant populations were divided into two groups; one group showed about 10 times resistance to carbamates and the other group showed 10-100 times resistance to carbamates. On the other hand, resistance patterns of resistant populations to organophosphate insecticides varied considerably with populations and insecticides. Acetylcholinesterase(AChE) in populations with high level of resistance to carbamates was found to be less sensitive to methyl carbamates and dimethyl organophosphates than that in others. It was proved that the reduction in sensitivity of AChE to inhibition was the major resistance factor of the carbamate-resistance and a part of dimethyl organophosphate-resistance. Furthermore, it was shown that the reduction in sensitivity of AChE to inhibition was a result of appearance of a modified type of AChE.

14S-4,23 THE ROLE OF DIFFERENT METABOLIC PATHWAYS IN ORGANOPHOSPHORUS RESISTANCE IN THE HOUSEFLY, *MUSCA DOMESTICA* L.

Motoyama, N. (Fac. Horticul., Chiba Univ., Matsudo, 271 Japan)

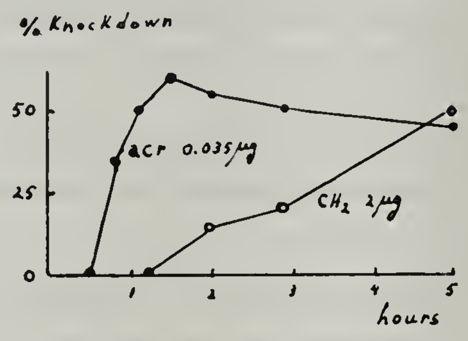
Among various enzymes which catalyse degradation of organophosphorus (OP) insecticides, phosphorotriester hydrolase, carboxylesterase, GSH S-transferase, and mixed-function oxidases(MFO) have been well documented for their involvement in OP resistance. However, since certain resistant strains possess these enzymes overlappingly, and many OP insecticides are subject to simultaneous attacks *in vitro* by more than one of these enzymes, the role that each enzyme actually plays for resistance *in vivo* is not always clear. The present paper, therefore, attempts to correlate the *in vitro* and *in vivo* information on these enzymes. A comparative metabolism of diazinon as a model compound in resistant and susceptible houseflies as well as in the rat was studied. The results demonstrated that the importance of a particular metabolic pathway, *e.g.* MFO or GSH S-transferase, as a resistance mechanism would vary depending upon the strains.

14S-4,24 INTERACTION OF ALTERED SITES OF ACTION WITH DETOXICATION MECHANISMS IN THE HOUSEFLY.

Oppenoorth, F.J. (Institute for Pesticide Research, Marijkeweg 22, 6709 PG Wageningen, the Netherlands)

An altered site of action will be different in its effect on toxicity depending on whether an insecticide acts reversibly or irreversibly. In the case of irreversible inhibition of acetylcholinesterase (AChE) by OP's a reduction of the rate of inhibition as found in mutant AChE will only postpone death, unless the insecticide is removed, e.g. by detoxication. An example is the resistance to tetrachlorvinphos (4x) caused by mutant AChE with an 18 fold reduced rate of inhibition, compared with resistance to paraoxon (53x). The difference is due to the fact that the latter compound is degraded oxidatively, whereas the former is not. If oxidation is blocked the difference disappears. Genes for increased detoxication greatly enlarge the effect of recuded rate of inhibition, resulting in high degrees of resistance.

A reduced affinity of a reversibly inhibited site of action, as in kdr and super-kdr mutants resistance to pyrethroids and DDT leads to resistance even in the absence of detoxication. Since it takes longer for a toxic dose to accumulate, detoxication factors also in this case can greatly increase resistance.



Time course of intoxication of two strains topically applied with equitoxic dosages of paraoxon. Acr with normal AChE, CH_2 with mutant AChE with a 23 fold reduced rate of inhibition.

14S-4,25 MECHANISMS OF RESISTANCE TO PYRETHROID (PY), ORGANOPHOSPHATE (OP) AND HORMONE-TYPE (IGR) CHEMICALS IN MOSQUITOES.

Georghiou, G. P. and Pasteur, N. (Dept. Ent., Univ. of Calif., Riverside, Calif. 92521 U.S.A.)

Resistance to OPs occurs in several populations of *Anopheles*, *Culex*, and *Aedes*, but resistance to PYs and IGRs has not been reported to date, possibly due to their limited use under field conditions. The work reported here concerns OP-R strains which appeared in the field and were selected further in the laboratory, and PY-R and IGR-R strains that were developed by laboratory selection alone.

Evidence from synergism and electrophoresis indicates that OP resistance in *Culex* is based on esterase detoxication. A single genetic factor is involved which may impart different levels of OP resistance, possibly as a result of gene amplification. The spectrum of resistance may be narrow (malathion-R) or wide affecting several diverse OPs. A mechanism of reduced penetration enhances OP resistance in *C. tarsalis*. No reduction of AChE sensitivity to OPs was found in OP-R *Culex*, but in *An. albimanus* this is the primary mechanism for ~100X resistance to parathion and high resistance to carbamates.

A broad spectrum of resistance to PYs was induced in *C. quinquefasciatus* by selection with permethrin. This resistance is not due to changes in metabolism or penetration but to decreased sensitivity of the nervous system toward PYs caused by the mechanism *kdr*. The latter is also responsible for similar insensitivity to DDT. In *C. quinquefasciatus* and *An. stephensi*, PY and DDT resistances rise concurrently during selection by either permethrin or DDT.

Resistance to the IGR methoprene was induced by selection in *C. tarsalis* to a level ~300X the normal ED_{50}. Induction of similarly high resistance was reported for *C. pipiens*. Studies with radiolabelled permethrin in *C. tarsalis* indicated that resistance is not due to decreased penetration. In *C. pipiens*, similar studies provided evidence of increased detoxication as a factor for resistance.

14S-5,26

FORMAL GENETICS OF THE HOUSEFLY IN RELATION TO INSECTICIDE RESISTANCE.

Hiroyoshi, T. (Dept. Genet., Osaka Univ. Med. School, Osaka 530, Japan)

The early attempts to assemble marker mutants of the housefly, *Musca domestica* L., by Bodenstein (1940), Sarkissian and Serebrovsky (1941) were unfortunately interrupted and not connected to the recent study. Since the first discovery of houseflies resistance to DDT in the late 1940's, however, the importance of basic genetic studies of this insect has been recognized and studies with an emphasis on the accumulation of marked chromosomes have been undertaken by several investigators. Marker mutants thus obtained have been utilized as useful tools in the study to reveal the mode of inheritance of resistance and also to invent suitable fly materials for biochemical analyses. In order to make possible more sophiscated studies on the resistance problem, we have continuously extended our works and attempted to prepare more refine linkage maps of the housefly. The newest maps we have prepared will be shown and discussed in relation to insecticide resistance. During the process of these studies, a number of anomalous houseflies whose sexes were not determined by so called "sex-chromosomes", X and Y, but determined by autosomal sex-factors (M-factors on the 1st, 2nd, 3rd and/or 5th chromosomes, and F-factor on the 4th chromosome) were found. Recently, we realized that the frequency of occurrence of such anomalous flies was rapidly increased to overdominate the normal typed flies in some areas in the world. And such a change seemed to be correlated with the development of resistance to insecticides. The importance of the study on the sex-determination in the housefly will be discussed.

14S-5,27

THE ROLES OF STRUCTURAL AND REGULATOR GENES IN INSECTICIDE RESISTANCE.

Plapp, F. W., Jr. (Dept. of Entomology, Texas A&M Univ. College Sta. TX 77843 USA)

Biochemical and genetic experiments were conducted with several insecticide resistant strains of the housefly , *Musca domestica* L. Resistance mechanisms measured included altered ali-esterase, altered acetylcholinesterase, microsomal oxidase, glutathione transferase, and DDT dehydrochlorinase. Genetic assays indicate that a common gene locus on chromosome II (or several closely linked genes) is involved in the inheritance of resistance in many strains. High levels of resistance and dominance of inheritance are associated with a significant suppression of crossing-over on this chromosome. Additional experiments established that a portion of resistance is controlled by genes located either on other chromosomes or at distinct loci on chromosome II. Full expression of resistance is due to the interaction of the common gene locus and other resistance genes. Induction experiments indicate that the common gene on chromosome II is regulatory in nature and acts as an intensifier on the effect of other resistance genes.

14S-5,28

MECHANISMS OF RESISTANCE TO PYRETHROID INSECTICIDES IN INSECTS.

Sawicki,R.M. (Insecticides and Fungicides Department, Rothamsted Experimental Station, Harpenden, Herts., U.K.)

Pyrethroid-resistance has been definitely confirmed only in relatively few species of arthropods. So far it has occurred mainly as a result of the development of resistance to other insecticides because pyrethroid resistance often forms part of the cross-resistance spectrum of mechanisms selected by insecticides chemically unrelated to pyrethroids. The most common resistance mechanism knock-down resistance (*kdr*), thought to have been originally selected by DDT, is a non-metabolic factor assumed to decrease nerve insensitivity to the organochlorine and pyrethroid insecticides. Metabolic resistance mechanisms recently isolated in *Musca domestica* have been studied by genetic and other techniques and shown to give in combination with *kdr* or its allele(s) strong or very strong resistance to pyrethroids.

The characteristics and cross-resistance of some of these pyrethroid-resistance mechanisms are discussed.

14S-5,29 ESTERASES AND ORGANOPHOSPHATE RESISTANCE IN MOSQUITOES. Pasteur, N. and Georghiou, G. P. (Centre National De La Recherche Scientifique, France).

Resistance of several *Culex* species to a large variety of organophosphate compounds is associated with the presence of abnormally active esterases. In *C. pipiens*, two esterases (B and A'), presumably coded by different genes, are present either alone (esterase-B in California, esterase A' in France), or together (East Africa). In French and California populations, OP resistance is monofactorial, and the gene of resistance in each country is either identical to the esterase gene present, or tightly linked to it (no recombinants). There is evidence that in California populations, the resistance gene exists in different forms, each form inducing different levels of resistance. These findings will be discussed in relation to variations in esterase activity. Plausible mechanisms for this phenomenon, e.g. point of mutation, gene regulation and gene amplification, will be considered.

14S-5,30 SELECTION PRESSURE ON INSECTICIDE RESISTANCE GENES IN WILD MOSQUITO POPULATIONS. Curtis, C. F. (Ross Institute, London Sch. of Hygiene & Trop. Med., London WC1E 7HT, U.K.)

Attempts are being made to evaluate the pressures of natural selection on resistance genes by:

1. review of data on the rate of build up of resistance in sprayed areas and of reversions to susceptibility in unsprayed areas;
2. mark, release and recapture of mosquitoes of known resistance genotype;
3. testing the toxicity to larvae of known genotype of waters which have been sprayed with larvicides or contaminated by agricultural spraying;
4. study of the duration of house resting.

Attention is focussed on selective killing of susceptibles but not resistants, on whether heterozygotes are killed under field conditions, the effect of aging of insecticide deposits and the vulnerability of males. The intention is to use the data to assess the feasibility of various proposed methods to inhibit the evolution of insecticide resistance.

14S-6,31 Rizwanul Haque (U.S. Environmental Protection Agency, Washington, D.C. 20460

DYNAMICS OF PESTICIDES AND TOXIC CHEMICALS IN AQUATIC ENVIRONMENTS
Rizwanul Haque, U.S. Environmental Protection Agency, Washington, D.C. 20460

The movement and fate of pesticides and toxic chemicals in aquatic environments is critical in defining risk to humans and the environment. Transport and Transformation processes such as bioaccumulation, adsorption, hydrolysis, photolysis and microbial degradation are important in defining the exposure concentration of toxic chemicals. Exposure data in turn in conjunction with effects information provide risk assessment. The U.S. Environmental Protection Agency has an active research program to develop models for estimating exposure concentration of toxic chemicals in water. This presentation will focus on the description of this research area. This research information is needed in regulation of chemicals in the U.S. under the Toxic Substances Control Act and the Federal Insecticide Fungicide and Rodenticide Act. EPA laboratories have developed testing protocols for defining transport and fate of toxic chemicals. Transport and Transformation information has been used to develop Exposure Analysis Modeling System. Such models are being validated in laboratory microcosms. EXAMS are capable of predicting concentration of toxic chemicals in water.

14S-6,32 FISH METABOLISM OF CYCLODIENES AND THEIR PRECURSOR AND PHOTOISOMERS.

Khan, M.A.Q., Sudershan, P., Podowski, A.A. and Feroz, M. (Dept. of Biol. Sci., Univ. of Illinois, Chicago, IL (U.S.A.)

Metabolism of ^{14}C-labelled hexachlorocyclopentadiene (precursor of cyclodienes), endrin, dieldrin, *cis*-chlordane, heptachlor, photo-*cis*-chlordane, and photodieldrin studied in goldfish, cichlid, and bluegill showed species variations in the rate and extent of biotransformation of the same chemical as well as in the biotransformation of various chemicals by the same species. *Cis*-chlordane is the most stable of these chemicals. Percent of the absorbed chlordane metabolized was: 0.13 by goldfish, 7 by bluegill, and 13 by cichlid; only cichlids showed the presence of dichlorochlordene and oxychlordane. About 15% of the absorbed photo-*cis*-chlordane was metabolized by bluegill to polar and apolar products. 10% of the absorbed photodieldrin was metabolized by goldfish and bluegill, the former producing only photodieldrin ketone and the latter both the ketone and photoaldrin *trans*-diol. Dieldrin was metabolized at a slower rate than photodieldrin. About 30% of the absorbed endrin was metabolized by bluegills to 6 products, all of which were conjugates; none was the toxic ketone. Hexachlorocyclopentadiene was rather rapidly metabolized by goldfish to at least 6 organosoluble metabolites some of which may be excreted as polyhydroxy derivatives and conjugates.

14S-6,33 METABOLIC CHANGES OF PESTICIDE RESIDUES IN AQUATIC ENVIRONMENTS BY MICRO-ORGANISMS.

Matsumura, F. (Pesticide Res. Centr., Michigan State Univ., E. Lansing, MI 48824 U.S.A.)

Microbial activities contribute to overall degradation and metabolism of pesticidal chemicals in both enzymatic and nonenzymatic ways. One type of microbial degradation involves non-energy yielding enzyme actions which induce no growth in microbial population. In this type of metabolism microbes therfore depend upon other carbon sources for their growth. The degradation systems involved are often wide spectrum enzymes such as hydrolases. The other type of microbial activities involves energy yielding enzyme reactions(i.e. catabolism). The difference between these two types of enzymatic metabolism are discussed. As to nonenzymatic reactions that microbes are known to be involved are: Photosensitizers, metabolic cofactor ions and organic reactants to promote conversion of pesticidal molecules. The reactions involving electron transfer proteins such as flavoprotein and ferridoxin are described in detail.

14S-6,34 ACUTE TOXICITY OF PESTICIDES IN SOME COMMON FRESHWATER ORGANISMS IN JAPAN

Hashimoto, Y. and Nishiuchi, Y. (Tokai Reg Res Lab., Ueda, Nagano, 386 Japan)

The acute toxicity of pesticides in freshwater organisms, especially in carp, *Cyprinus carpio*, were studied.

In carp, the effects of test temperature and PH, administration route, formulation and combination of pesticicides upon the toxicity were observed.

LC-50 values were determined in *Carassius auratus*, *Misgurnus anguillicaudatus*, *Oryzias latipes*, *Daphnia pulex*, *D. carinata*, *Moina macrocopa*, *Procambrus clarkii*, *Semisulcospira libertina*, *Cipangopaludina malleata* etc. for comparison.

14S-6,35 MEASURMENT OF BIOCONCENTRATION FACTORS OF PESTICIDES BY FRESHWATER FISH AND THEIR CORRELATION TO PHYSICO-CHEMICAL PROPERTY OR ACUTE TOXICITY.

KANAZAWA, JUN (Nat. Inst. Agr. Sci., Tsukuba, Ibaraki 305, Japan)

Bioconcentration factors (BCFs) of fifteen pesticides by freshwater fish (topmouth gudgeon) were measured under the continuous flow water containing 5 to 20 ppb of each pesticides at the equilibrium condition. A significant correlation were found between BCF by fish and water solubility or partition coefficient (PC) between n-octanol and water. Moreover, a significant correlation were also found between BCF by topmouth gudgeon and acute toxicities to carp, rainbow trout and water flea. Therefore, the bioconcentration potential of pesticides by fish are able to predict by the water solubility or PC. While the acute toxicity of pesticides to fishes are able to predict by the BCF.

14S-7,36 NERVE MEMBRANE IONIC CHANNELS AS THE TARGET SITE OF INSECTICIDES.

Narahashi, T. (Dept. Pharmacol., Northwestern Univ. Med. Sch., Chicago,IL 60611 USA)

An action potential is generated as a result of opening and closing of nerve membrane ionic channels. It has now been established that sodium channels are particularly vulnerable to DDT and pyrethroids being modified to give rise to very slow kinetics of opening and closing. This action accounts for the symptoms of poisoning in insects and other animals. This presentation is mainly concerned with the mechanism whereby the DDT and pyrethroid insecticides modify the sodium channel function. Tetramethrin, allethrin, DDT and EDO, an oxetane derivative of DDT, were examined for their effects on the giant axons of the squid, crayfish and lobsters using voltage clamp techniques. Following application of tetramethrin or allethrin, the peak transient sodium current associated with a step depolarization was followed by a secondary, slowly developing, and very slowly decaying current. The slow current is carried by sodium through the sodium channel, because it was blocked by tetrodotoxin or sodium-free media. It was activated at more negative membrane potentials than those where the peak sodium current could be generated. Furthermore, the peak current in the poisoned axon exhibited the same kinetics and voltage dependence as that in the normal axon. These and other observations indicate that the slow current is generated by a population of sodium channels that has been modified in kinetics by the insecticide. DDT and EDO had basically similar effects on the sodium channels. However, there were large differences in potency among optical and geometric isomers of the pyrethroids, suggesting that the binding site has some specific configurations and properties capable of accepting only the active isomers. Alternatively, the inactive isomers, though being able to bind to the site, cannot modify the sodium channels. Supported by NIH grant NS 14143.

14S-7,37 NEUROPHYSIOLOGICAL CORRELATES OF PYRETHROID AND DDT POISONING IN INSECTS.

Miller, T. (Dept. Ent., Univ. of Calif., Riverside, CA 92521 U.S.A.)

By recording neuromuscular activity from intact or dissected insects and by using various strains of resistant insects, we have reached the following tentative conclusions: Pyrethroids and DDT share the same general mode of action. The primary toxic action of some compounds is located outside of the central nervous system. The so-called kdr resistance factor renders both the peripheral and central nervous system less sensitive to direct application of pyrethroids or DDT. Pyrethroids and DDT act only at highly specific sites in the nervous system and are not general nerve poisons in the sense of local anesthetics.

14S-7,38

CENTRAL SYNAPTIC ACTIONS OF PHARMACOLOGICAL AGENTS IN INSECTS. Callec J.J. (Lab. Physiol. An. Univ. Rennes, France).

The synaptic membrane as a target site for pharmacological agents including insecticides has been the subject of many investigations. However it is not well understood how such compounds modify transmission in insects because of the multiplicity of potential sites of action and the technical difficulties for investigation at the synaptic level. During the past decade, we have attempted, using external recording methods for synaptic events in the "cercal nerve-giant fibre system" of the cockroach, to provide experimental approaches to the study of central actions of neurotoxicants. We shall give typical results obtained with the "oil-gap" and "mannitol-gap" methods.

- Cholinergic agents: Several agonists and antagonists have been tested: acetylcholine, carbachol, nicotine, pilocarpine, decamethonium, atropine, d-tubocurarine, α-bungarotoxin, nereistoxin. The relatives potencies are compared using dose-responses curves.
- Isothiocyanates: Synthetized as potential insecticides, these compounds were found to be potent inhibitors of choline acetyltransferase. More recently, it appears that at higher concentrations one of them is effective at an α-bungarotoxin sensitive acetylcholine receptor.
- 4-Aminopyridine increases transmitter release whereas it depolarizes the postsynaptic membrane without cholinergic receptor intervention.
- Taurine and GABA: These two amino-acids exert a depressant action upon synaptic transmission. This is achieved through an increased conductance of pre-and postsynaptic membranes to chloride ions.

14S-7,39

THE INHIBITORY ACTION OF L-GLUTAMIC ACID ESTERS AND CURARE ON THE INSECT NEUROMUSCULAR JUNCTION. Washio, H. and Yamamoto D. (Mitsubishi-Kasei Inst. Life Sci., Machida, Tokyo 194 Japan)

Recent work on L-glutamic acid esters in the insect neuromuscular junction revealed that α-methyl esters of L-glutamic acid blocked the neuromuscular transmission while the diesters was less effective. The amplitude of the intra- and extracellular EPSPs was reduced by the treatment of 10 mM γ-esters in a few minutes. The study on the effect of L-glutamate and acetylcholine on the ventral muscle fibers of the larval mealworm showed the evidence favouring glutamate as a transmitter of the junctional excitation. We have analyzed the action of curare and found the curare blocked the glutaminergic transmission by antagonizing the transmitter at the postsynaptic sites in this muscle fibers. The non-competitive antagonism of curare against glutamate-induced depolarisation has been taken as evidence that the drug blocks ionic channels mediated by the transmitter rather than acting on the receptor itself.

14R-1,1

TOXICITY RESPONSE OF RICE-HOPPERS AND THEIR NATURAL ENEMIES AND RICE SHEATH BLIGHT TO PESTICIDE COMBINATIONS. Ku, T. Y., (Dept. Agri. Production, Council Agri. Planning & Develop., Taipei 107, Taiwan, Republic of China)

The toxicity of five insecticides, five fungicides and their paired mixtures to brown planthopper (Nilaparvata lugens), green rice leafhopper (Nephotettix cincticeps), rice sheath blight (Thanatephorus cucumeris), and rice-hoppers' natural enemies (wolf spider, Lycosa pseudoannulata, and mirid bug, Cytorhinus lividipennis) has been tested. The insecticides include Furadan, Hokbal, MIPC, Orthene, and Unden; the fungicides are Benlate, Asozin, Mon, Mon San, and Neo Asozin. Among the various combinations of tested chemicals, Hokbal + Asozin, Benlate + MIPC, Benlate + Mon San produce an increasing toxicity (with a co-toxicity coefficient of greater than 100) to rice-hoppers and sheath blight but a decreasing toxicity to rice-hoppers' natural enemies. If judged by their capabilities of effectively controlling rice insect pests and sheath blight while simultaneously protecting rice-hoppers' natural enemies, such mixtures have the best selectivity. Furadan + Neo Asozin and Orthene + Mon San show antagonistic effects with a reducing toxicity to rice-hoppers and rice sheath blight; they have an enhanced toxicity to mirid bugs but show no apparent alteration of toxicity to wolf spiders. Other paired mixtures reveal an irregular variation of toxicity to rice-hoppers and their natural enemies and to sheath blight.

14R-1,2 Selective toxicity of some pyrethroids in the armyworm, *Leucania separata* (W.) Brempong-Yeboah, C. Y., Miyata, T. and Saito, T. (Lab. of Appl. Ent. and Nematol., Fac. of Agric., Nagoya Univ., Chikusa, Nagoya, 464 Japan)

The armyworm, *Leucania separata* Walker is one of the serious insect pests of gramineous crops and grasses.Recently many synthetic pyrethroids have been developed and have been introduced to the control of not only medical insect pests but also agricultural insect pests. The toxicity of certain synthetic pyrethroids and natural pyrethrins against armyworm larvae was studied. Effect of application method or relationship between chemical structure and toxicity will be discussed.

14R-1,3 TOXICOLOGICAL PROPERTIES OF PHOSPHOROTHIOATE AND DITHIOATE IMPURITIES PRESENT IN TECHNICAL ORGANOPHOSPHORUS INSECTICIDES. Umetsu, N., Mallipudi, N. M., Toia, R. F., Hammond, P. S., March, R. B., Talcott, R. E., and Fukuto, T. R. (Dept. Ent., Div. Tox. & Phys., Univ. of Calif., Riverside, Calif. 92521 U.S.A.)

O,O,S-Trimethyl phosphorothioate (I), an impurity present in some technical organophosphorus insecticides, administered orally to rats caused mortality in a slower, more insidious manner than death caused by typical anticholinesterase organophosphorus insecticides. At doses of 15-80 mg/kg, death occurred 4-22 days following treatment. The estimated LD_{50} value was 15 to 20 mg/kg. At the LD_{50} dose, the physical appearance of the animals was normal, but a gradual loss in weight was observed. In contrast, at the 200 mg/kg dose (48 hr LD_{50}) diarrhea, excess urination and bleeding from mouth, nose and eye accompanied weight loss. *O,S,S*-Trimethyl phosphorodithioate (II) and *O,O,S*-triethyl phosphorothioate (III) and related esters also were examined for delayed toxicity. Purified II produced the same kinds of intoxication symptoms and the estimated LD_{50} value was about 40 mg/kg. Although the same kinds of intoxication symptoms were observed with compound III (LD_{50} after 8 days, 45-90 mg/kg), death occurred at shorter time intervals compared to the trimethyl esters. Synthesis of I from trimethyl phosphite and methylsulfenyl chloride gave a product which was contaminated with ~3% of the isomeric *O,O,O*-trimethyl phosphorothioate (IV). This mixture did not cause adverse effects at the 200 mg/kg level. Subsequent co-administration studies showed IV to be a potent antagonist of I. At 200 mg/kg of I, mortality was prevented by the addition of 1% (w/w) IV. Antagonism of the toxicity of II by IV also was observed.

14R-1,4 The Toxicological and Biochemical Studies of An Organochlorine Insecticide MEB 6046 (2,2,2-Trichloro-1-(3,4-Dichlorophenyl) Ethanol Acetate)

Hsiung Yao (Institute of Zoology,Academia sinica, Peking, China)

The insecticidal effect,toxicity toward mammals and mean metabolic products of MEB 6046 from mammals were studied.The results showed that the compound is extremely safe toward mammals and is not accumulative in the animal body when treated with high doses for a period ofconsecutive feeding.Most of the toxicant excrets out through feces and urine of the mice as the original compound and the alcohol, 2,2,2-Trichloro-1-(3,4-dichlorophenyl) ethanol. Another metabolite, 2,2-dichloro-1-(3,4-dichlorophenyl) ethanol was found and identified instrumentally with synthetic sample.Experiment showed that this compound is not carcinogenic,mutagenic nor teratogenic.The effectness of this compound to adults of mosquitoes and houseflies is at the DDT level or somewhat better.

14R-2,5

EFFECT OF CHEMOSTERILANTS ON THE SPERMATOGENESIS OF *PERIPLANATA AMERICANA*. Mishra, R. K. and Jha, L. K. (P. G. Dept. of Zoology, Mithila Univ., Darbhanga, Bihar, India

The effect of bisazir (p,p-bis (1-aziridinyl) -N-methyl-phosphinothioic amide) and tin compound (triphenyl hydroxide) on the spermatogenesis has been observed. Both chemosterilants have been found effective at different level viz. spermatogonia, primary and secondary spermatocytes, spermatids and spermatozoa. At lower dose of chemosterilants, spermatogonia and primary spermatocyte have been found pycnotic. Secondary spermatocyte and spermatids show hypertrophy, however, spermatozoa have been observed hypertrophic at higher dose. Even the Golgi complex and mitochondria have been found damaged. Bisazir has been found more effective than tin compound.

14R-2,6

HISTOPATHOLOGICAL AND BIOCHEMICAL STUDIES ON THE TESTIS OF *PERIPLANETA AMERICANA* TREATED WITH STERILANT COMPOUNDS. Bhatnagar, P. and Saxena, S.C. (Dept. Zool., Rajasthan Univ., Jaipur, 302004, India)

The effective doses of hempa, thio-tepa and bis(dimethylamino)dithiazolium chloride cause severe pathological damages to testis. These include fragmentation and clumping of the chromatin material, formation of giant cells, cytoplasmic disintegration and necrosis of cell and testes. It is observed that primary stages of spermatogenesis are more sensitive to the sterilant compounds. The cells of follicular layer are also affected. Biochemical study of treated american cockroach reveals a significant rise in protein and cholesterol levels. It is suggested that the changes in the cholesterol and protein level coupled with pathological damages in the testis may be the cause of sterility in cockroaches treated with sterilant compounds.

14R-2,7

RAMADE François

Acute poisoning of *Locusta* by topical application of Lindane at sublethal dosages induces various alterations in the corpora cardiaca and corpora allata at ultrastructural level. We have shown up several changes in shape and electron density of neurosecretory granules in the nervous and glandular part of corpus cardiacum. Other conspicuous alterations of golgi system, endoplasmic reticulum and lysosomes are described. The type of cell degeneration observed in corpora allata is similar to ultrastructural changes obtained after the administration of precocene 2, an anti-juvenile hormone.

14R-2,8 PHENOLOXIDASE AND ITS INTERACTION WITH DIFLUBENZURON IN *SPODOPTERA LITTORALIS*

El-Sebae A.H., Soliman S.A., El-Gindy K., and Khames A., Plant Protection Dept., Faculty of Agric.
Alexandria University, Alexandria, Egypt.

The mean specific activity of phenoloxidase in *Spodoptera littoralis* pupal homogenate was found to be 8.761 extinction units. Km was calculated to be 2.7 nM, while V max was 12.5 e.v. The enzymeactivity increase 22 fold in sixth instar larvae than the first instar. Phenoloxidase reached a maximum 3-4-days after puparian formation. Diflubenzuron up to 1 x 10^{-4} M inhibits only 39% of third instar larvae enzyme activity *in-vitro*. Diflubenzuron showed a time dependent stowach toxicity to *S. littoralis* larvae. Diflubenzuron caused clear disturbance in ecdysis of *S. littoralis* larvae and retards the moulting process.

14R-2,9 THE ELECTROPHYSIOLOGICAL EFFECTS OF DIRECT APPLICATION OF DDT DISSOLVED IN ORGANIC SOLVENTS, ON THE VENTRAL NERVE CORD OF AMERICAN COCKROACH.

Giannotti, O., Holzhacker, E.L.(Instituto Biológico, São Paulo, Brasil - C.P. 7119)

By the manitol-gap tecnique (Callec,Satelle-J.Exp.Biol.-1973), it was possible to observe the effects of insecticides dissolved in 1λ organic solvents when applied directly on the ventral nerve cord of american cockroach. In the present case was studied the effect of DDT, 3-4hs after the treatment;the following observations were made:1) Acetone blocked the nerve conduction. 2) Hexane had any effect on the conduction. The external action potential (P.A.) was the same as in the control (in 7 preparations, 5 with no reduction and 2 with a reduction between 1-25%); no alteration in the outline of P.A. was observed. 3) A mixture of hexane and acetone 7:3, may cause only a slight reduction of the P.A.(in 18 preparations, 10 with a reduction between 0-25%, 5 between 26-49% and 3 with a reduction of 50%. 4) DDT (5ug.) dissolved in 2 cause an increase in the negative after potencial(N.A.P) already observed by Yamasaki-Narahashi-1957, but slight reduction in P.A.(in 7 preparations, 2 with a reduction between 0-25%, 4 between 26-49 and 1 with a reduction of 50%,5), DDT (5ug.) dissolved in 3, besides the increase of N.A.P., cause a high reduction of P.A. (in 21 preparations, 3 with a reduction between 0-25%, 4 between 26-49%, 7 between 50-75% and and 9 between 76-100%), 6) The results suggest an evidence of the effect of DDT, when dissolved in 3, on Na^+ permeability, caused probably by the penetration of the insecticide in more polar phases of the membrane.

14R-3,10 INSECTICIDE RESISTANCE IN THE BROWN PLANTHOPPER (*NILAPARVATA LUGENS*).

Nagata, T., and Masuda, T. (Kyushu National Agricultural Experiment Station, Chikugo, Fukuoka, 833, Japan)

The brown planthopper (*Nilaparvata lugens*), one of the major rice insects in Japan, have been controled with insecticides successfully for nearly 30 years. However, the effects of insecticides are decreasing recently due to gradual development of insecticide resistance to the organophosphates followed by the carbamates, which have been demonstrated by continuous long-term survey of the insecticide susceptibility since 1967 by our micro-topical application method. In Japan, the brown planthopper is considered to immigrate from distant oversea sources every summer. It showed a particular seasonal fluctuation and little regional difference in insecticide susceptibility and slow developing rate of insecticide resistance which were considered to be associated with migration. In comparative studies of toxicological properties of the rice planthoppers collected from the Southeast Asia, the brown planthopper and the white backed planthopper (*Sogatella furcifera*)from tropical regions (Philippines, Thailand) showed considerably different patterns in insecticide susceptibility and hereditary tendency to produce more brachypterous form as compared with those obtained from the temparate regions (Taiwan, Japan). The meaning of these geographical variations was discussed.

14R-3,11 Studies on the resistance of diamondback moth, *Plutella xylostella* to commonly used insecticides. *Lee*,S; and Lee,W;(Taiwan Agr.Res.Inst; Wufeng,Taichung,Taiwan)

In order to understand the present status of insecticide resistance of diamondback moth, the resistance spectra of this insect strains collected from various vegetable field of Taiwan was determined by topical application using several insecticides. Most of the strains showed a relatively high level of resistance to commonly used insecticides such as malathion, diazinon, DDVP, mevinphos, phenthoate and endosulfan. The multiple resistance of diamondback moth to quite a few insecticides was also found in some field strains. This phenomenon might be considered to be a primary obstacle to successful contrl of the insect by several insecticides today in Taiwan.

14R-3,12 INSECT ACETYLCHOLINESTERASE INHIBITION AUTOANALYSIS: INTERSPECIES AND INTERSTRAIN DIFFERENCES. Voss, G. (Agric. Div., CIBA-GEIGY Ltd., Basle, Switzerland)

A Technicon AutoAnalyzer system was used to evaluate differential inhibitor sensitivities of acetylcholinesterases (AChE) from several insect species and insecticide resistant races *in vitro*. A short preinhibition of the various AChE's with a series of organophosphate (OP) and carbamate insecticides (0.2 ppm carbofuran, 2 ppm *N*-ethyl-carbofuran, 20 ppm *N*-propyl-carbofuran, 1 ppm carbaryl, 1 ppm mevinphos, 0.2 ppm dichlorvos, 5 ppm methomyl) resulted in reproducible "inhibition patterns" on the recorder chart. These patterns varied among representatives of different insect orders (i.e. between *Musca domestica* and *Heliothis virescens*, or between *Apis mellifera* and *Tenebrio molitor*), but were surprisingly similar when closely related insect species (i.e. *Musca domestica*, *Lucilia sericata*, and *Calliphora erythrocephala*, or various lepidopterous species) were compared. Insecticide resistant races of *Musca domestica* and *Spodoptera littoralis*, however, were characterized by AChE inhibition patterns which were drastically different from those of their susceptible counterparts. This particular feature proved to be an extremely useful tool to monitor certain insect populations on a routine basis (up to 60 single insect heads/hour) for individuals with a modified AChE and suspected OP-resistance.

14R-3,13 BIOCHEMICAL CHARACTER OF BROWN PLANTHOPPER (*NILAPARVATA LUGENS*) WHICH DEVELOPED RESISTANT TO PESTICIDES. Hasui, H. [Cyanamid (Japan), Ltd., Tokyo, Japan] and Ozaki, K. (Kagawa Pref. Agr. Exp. Sta., Kagawa, Japan)

Field population of *N. lugens* in Kagawa Pref. were 9, 12, 4 and 8-fold resistant to fenitrothion, fenthion, carbaryl and MPMC, respectively, in 1976. But resistant patterns were almost same as checked in 1967-1975. Malathion (Rm) and fenitrothion (Rf) resistant strains of *N. lugens* showed different resistant patterns in each strain and with field strains. Zymogrames of esterase and chE of susceptible (LE), Rm, Rf and field strains were checked by disk electrophoresis method. Zymogrames of esterase and chE were separated into 2 and 8 different bands and activity and pattern of zymogrames were different in each strain.

Esterase: Rm, Rf and field strains showed remarkably higher activity of E_1 and E_2 bands than LE strain.

chE: C_1 and C_5 bands were not detected in LE strain. Rm and Rf strains showed high activity of C_5 bands. Activity of C_6 band of Rm and field strains showed higher activity than LE strain, but Rf strain was lower than LE strain.

14R-4,14 CROSS-RESISTANCE TO INSECTICIDES IN THE SHEEP BLOWFLY (LUCILIA CUPRINA) AND ITS IMPLICATIONS.

Hughes, P.B. and Shanahan, G.J. (N.S.W. Dept. Agriculture, PMB 10, PO Rydalmere 2116, Australia).

Resistance in the sheep blowfly to insecticides in Australia has resulted from prolonged use of OP chemicals to control flystrike, and is now widespread. A study of cross-resistance in different populations suggests that the same mechanisms are involved in OP resistance and that OP and carbamate resistances are distinct. Although the number of genes involved is small, their frequency in the field is high. Biochemical studies have discovered differences in metabolism between susceptible and resistant insects and aspects of this work are discussed. The new triazine insecticides, to which OP resistant insects are susceptible, provide a means of overcoming this resistance to OPs in *Lucilia cuprina*.

14R-4,15 EFFECTS OF THE FUNGICIDE IBP AS A SYNERGIST ON THE METABOLISM OF MALATHION

Yeoh, C.L., Kuwano, E., Oshima, K. and Eto, M. (Dept. Agric. Chem., Kyushu Univ., Fukuoka, 812 Japan)

The fungicide IBP (S-benzyl diisopropyl phosphorothiolate) exerted significant synergism of malathion against organophosphate resistant strains of insects such as houseflies and green rice leafhoppers. In order to elucidate the mode of the synergistic action, the effects of IBP on the metabolism of malathion in insects and rats were investigated. IBP did not inhibit glutathione S-alkyl transferase activity of houseflies. As an inhibitor of esterases, IBP was considerably weaker than K-2 (2-phenoxy-4H-1,3,2-benzodioxaphosphorin 2-oxide) when p-nitrophenyl acetate was employed as a substrate. When malathion was used as a substrate, however, IBP inhibited significantly the carboxyesterase activity of rat liver, houseflies and leafhoppers. IBP had a weak inhibitory activity on rat liver microsomal mixed function oxidase.

14R-4,16 ORGANOPHOSPHORUS MULTIRESISTANCE IN CULEX PIPIENS MOLESTUS IN ISRAEL.

Pener, H. (Lab. Ent., Ministry of Health, Jerusalem, Israel)

Culex pipiens molestus is the most widespread mosquito in Israel. Heavy breeding during nine months of the year and intensive chemical control, against mosquitoes and in agriculture, have brought about the evolvement of multiresistant populations of *C. pipiens molestus* to OP - insecticides.

The OP - insecticides in use as mosquito larvicides are mainly fenthion, temephos and chlorpyriphos. Resistance levels determined on larvae of 12 different populations have shown a range of 6 - 122.5 times the normal LC_{90} for temephos, 5.4 - 85.7x for fenthion and 2.3 - 40x for chlorpyriphos.

In 1978 phenthoate (0,0 - dimethyl S-α-ethoxycarbonylbenzyl phosphorodithioate) was introduced as an alternative larvicide; Control failure at the advised dosage was observed in some populations. Laboratory testing showed a clear correlation between high resistance levels to chlorpyriphos and the efficacy of phentoate.

14R-5,17 RESIDUES OF CHLORINATED HYDROCARBON INSECTICIDES IN ASPARAGUS FIELDS IN TAIWAN.

Chen Yuh-Lin, Tsai Hsien-Shiow and Wang Yei-Shung. (Dept. Agr. Chem., National Taiwan Uni., Taipei, Taiwan, Republic of China)

Residues of the chlorinated hydrocarbon insecticides and some of their metabolites including DDT, DDD, DDE, γ-BHC, aldrin, dieldrin, heptachlor and heptachlor epoxide were checked in the soils collected from 120 locations of the asparagus fields in Taiwan. ECD-Glc with an equal part of the mixture of 7% OV-17 and 9% QF-1 as a column was employed. Detectable amounts were found to be 0.1 ppb for these insecticides.

Although these chlorinated hydrocarbon insecticides were banned for at least more than five years, still a minor amount of residues could be detected from the soils. The maximum amounts were found to be up to 252.5 ppb for DDE (119), 127.1 ppb for DDT (120), 74.2 ppb for dieldrin (56), 66.9 ppb for DDD (101), 42.2 ppb for heptachlor epoxide (10), 34.2 ppb for γ-BHC (120), 23.7 ppb for aldrin (86) and 13.8 ppb for heptachlor (52) out of 120samples (positive cases in parentheses). No significant difference was observed among the different types of soils and between the plowing layer and plow-sole layer. Small amounts of these insecticides were also found in the asparagus plants.

14R-5,18 METABOLISM OF ^{14}C-PHOTODIELDRIN IN GOLDFISH AND BLUEGILL

Sudershan, P. and Khan, M.A.Q. (Dept. of Biological Sciences, Univ. of Illinois at Chicago Circle, Chicago, Illinois 60680 U.S.A.

The comparative metabolism of ^{14}C-photodieldrin has been investigated in bluegill fish and goldfish following a 20 ppb exposure in a static system. The major metabolic pathway leading to the formation of a ketone derivative is present in both species; the differences being: a more rapid metabolism of photodieldrin in bluegill, 27% of the eliminated radiolabel in the case of bluegill and 59% in goldfish was due to the parent compound . Epoxide hydration product - photoaldrin diol, present in bluegill, was not detected in goldfish. A detailed TLC and GLC examination of other polar and non-polar metabolites is presented.

14R-5,19 FATE OF MERCURY IN SARCOSAPROPHAGOUS FLIES AND FLY EATING MEALWORMS

Nuorteva, P. and S.-L.Nuorteva (Dept.Envir.Sci.,Helsinki Univ.,00710 Helsinki,Finland

Sarcosaprophagous insects are at the top of food chains. Even in an unpolluted environment their food is loaded with bioaccumulated heavy metals. We have studied the transfer of mercury from dead vertebrates into blowflies (*Calliphoridae*). By feeding dead vertebrates to blowfly larvae, we detected a linear correlation between the mercury content in the food and in the emerging fly adults. The average bioaccumulation coefficient was 4.3 for flies reared on Finnish methyl mercury loaded fish but only 1.5 for flies reared on Yugoslavian fish loaded mainly with elementary mercury. Highest mercury contents were observed in the posterior part of the alimentary tract and in the Malpighian tubules. Two days after the emergence the adult flies excreted about a half of their mercury load. Consequently they had a low mercury content in their body, when they started to produce eggs. The eggs were practically free of mercury. In accordance to their effective mercury excretion, blowflies are not sensitive for mercury in their environment. Also the average mercury content in free living adult blowflies is rather low. Elevated mercury contents have, however, been observed in the nearest vicinity of the mercury mine in Idrija and in the vicinity of Äetsä caustic soda factory.
We fed heavily mercury contaminated (38.9 ppm) dry imagines of *Lucilia illustris* (Meig) to imagines of the mealworm (*Tenebrio molitor* L.). In 4 months the mercury content of the mealworm imagines rose up to 201-243 ppm (dry weight) and they died in "Minamata disease". The controls received dry flies with a mercury content of 0.19 ppm. They were healthy and had only 0.4-2.6 ppm Hg in their bodies when the ordinary experimental animals died.

14R-5,20 AN INTEGRATED STUDY OF SUBSTRATE-BIOLOGICAL SPECIES INTERACTION IN AN AQUATIC ECOSYSTEM.

Perry, A.S., and Gasith, A. (Dept. of Zool., Tel-Aviv Univ., Ramat-Aviv, ISRAEL)

A single application of 0.05 ppm parathion to a eutrophic fishpond ecosystem affected certain biotic components but had no detrimental effect on the overall community structure and function.

Within 2-5 days after its introduction parathion accumulated in zooplankton and fish to the extent of several hundred fold the initial concentration in water but declined by an order of magnitude within a week. Following treatment the concentration of parathion in water decreased exponentially with an average half-life of 2.7 days. Repeated applications of parathion at weekly intervals for 3 weeks resulted in a massive dieoff of aquatic insects followed by a dramatic increase in zooplankton biomass and a reduction in algal biomass. The chronic exposure to parathion did not adversely affect fish survival but temporarily reduced their growth rate, caused a severe stress of certain fish species and prevented the quick recovery of the ecosystem.

This study was supported by grant No. 1724/RB from the International Atomic Energy Agency, Vienna.

14P,1 EXPERIMENTS WITH SYNTHETIC PYRETROIDS ON COTTON IN IVOIRY COAST : THEIR USE IN A RURAL MEDIUM, THE PROBLEMS TO SOLVE

Angelini A. and Trijau J.P. (I.R.C.T. B.P 604, BOUAKE, R.C.I)

The cotton production in Ivoiry Coast has made rapid strides these last twenty years. The authors describe the parasitic facies in the various climatic areas.

Experiments have enabled us to determine the rates of decamethrin, fenvalerate, cypermethrin to control Heliothis armigera (Hb), Spodoptera littoralis (Boisd.), Cryptophlebia leucotreta (Meyrick), Pectinophora gossypiella (Saund.), Earias insulana (Boisd.) and Diparopsis watersi (Roths).

The authors give the evolution of the utilization of pesticides in Ivoiry Coast and tackle the problems set by the use of pyrethroids during the vegetation period : lack of efficiency against Polyphagotarsonemus latus (Banks) (Acarina, Tarsonemidae), deficiency in regard to the stinging insects.

14P,2 32.861 RP - AN EXPERIMENTAL INSECTICIDE FOR CONTROL OF RESISTANT STRAINS OF GREEN LEAFHOPPER ON RICE.

G. GALLINELLI - BP 9163 - 692630 LYON CEDEX I-FRANCE

32.861 RP IS A NEW INSECTICIDE FROM THE OXADIAZOLE GROUP OF COMPOUNDS. IT HAS LOW MAMMALIAN AND FISH TOXICITY, AND SHOWS ACTIVITY BY CONTACT AND INGESTION. IT DISPLAYS GOOD KNOWKDOWN EFFECT AND HAS SHORT PERSISTENCE IN PLANTS.
RESULTS OF GREENHOUSE AND FIELD TRIALS ON RICE IN JAPAN HAVE REVEALED GOOD EFFICACY AGAINST GREEN LEAFHOPPER (NEPHOTETTIX CINCTICEPS) OF PARTICULAR INTEREST IS THE EFFICACY DISPLAYED AGAINST STRAINS OF GREEN LEAFHOPPER RESISTANT TO CARBAMATES AND ORGANOPHOSPHORUS INSECTICIDES.

14P,3 INSECTICIDAL EFFECTS OF PHENTHOATE AGAINST THE ONION MAGGOT (HYLEMYA ANTIQUA). M.Hirose and M.Takahashi (Biol. & Chem. Research Lab., Nissan Chemical Ind. Ltd., Shiraoka-cho Saitama-ken, 349-02 Japan)

Phenthoate, O,O-dimethyl,S-[α-(ethoxycarbonylbenzyl)] phosphorothiolothiorate, is an insectide which has a very broad spectrum and a powerful insecticidal effect against many species of insects. Scince 1963, it has been widely used to control various species of insect in Japan and foreign countries.

We studied the insecticidal actions of phenthoate against a onion maggot, Hylemya antiqua, that is, efficacy on each stage of the onion maggot, knockdown speed, persistent effect, residual amount on the onion and the soil, and temperature-insecticidal effect correlation, and we got interesting results.

As the results of these tests, it is considered that phenthoate could be useful to control the onion maggot by the foliar spray.

14P,4 Mode of Insecticidal Action of Cartap in Application to Rice Nursery Box

M. Sakai, Y. Kono, S. Moriya,* M. Inoue, R. Morimoto and Y. Sato

— Res. Lab., Agr. Chem. Div., Takeda Chem. Ind.,Ltd. and *Nat. Inst. Agr. Sci.—

The application of cartap (CTP)[1] granules onto the soil surface of the rice nursery box prior to the mechanical transplanting is effective to control the early season damage in the paddy field caused by *Nephotettix cincticeps*, *Oulema oryzae* and *Chilo suppressalis*. The results of chemical analysis and bioassay accounted for that the effectiveness was mainly due to CTP brought into the soil in the seedling root-zone and translocated to the aerial part. The residual activity against the leaf and stem chewing insects (*O. oryzae* and *C. suppressalis*) corresponded to CTP concentration detected in the aerial part. To the contrary, it was suggested that the sucking insect (*N. cincticeps*) took the insecticide mainly from the phloem sap. CTP was effective not only in the lethal action, but also in the suppression of feeding behavior, growth, oviposition and virus transmission (by *N. cincticeps*). Neurophysiological and behavioral examinations demonstrated that the effects closely related to the nervous deterioration caused by synaptic blocking action of CTP.

1) *S,S'*-[2-(dimethylamino) trimethylene] bis(thiocarbamate) hydrochloride (Padan®)

14P,5 PURIFICATION AND PROPERTY OF HORNET NEUROTOXIN,MANDARATOXIN.Takashi Abe, Nobufumi Kawai,* Akiko Niwa,* Takashi Tatsuno and Jun-ichi Fukami. Institute of Physical and Chemical Research, and * Metropolitan Institute for Neurosciences.

In this study, we show the purification and property of a new presynaptically acting toxin fromthe hornet, Vespa mandarinia,named Mandaratoxin(MDX). For isolation of MDX, the crude venom prepared by ultracentrifugation at 110,000 x g for 60 min was chromatographed in order by Sephadex G-50, CM-Sephadex and hydroxylapatite. The isolated toxin was shown a single band on polyacrylamide gel and SDS-polyacrylamide gel by electrophoresis. The molecular weight was estimated 21,000 daltones by SDS-polyacrylamide gel electrophoresis. The amino acid composition of MDX was determined by amino acid analyzer using phthaldialdehyde, and a large amount of basic amino acids were identified. The toxin had no enzymatic activities of proteinase phospholipase and esterase, nor hemolytic activity. Using lobster walking leg, the effect of the toxin on neuromuscler transmission was studied. MDX irreversibly blocked excitatory post synaptic potential without applicable change in the resting menbrane conductance of the post synaptic menbrane. By intracellular recording from the presynaptic fiber, it was found that the toxin primarily reduced sodium current and blocked action potential reaching to the nerve terminal.

14P,6 Three Toxic Mechanisms Associated with Xanthene Dyes in Insects. Heitz, J. R. (Dept. Biochem., Miss. State Univ., Miss. State, MS 39762 U.S.A.)

Several species of insect have been shown to die when exposed to visible light after ingestion of certain xanthene dyes. The toxic reaction is dependent on several experimental parameters, but is relatively rapid when compared to the toxicity of these same dyes in the absence of light. Both the light dependent and light independent mechanisms have been studied in larval and adult insect stages. A third toxic reaction has been observed in larvae treated with sublethal doses of dyes by the above two mechanisms. Developmental abnormalities become evident in the larval and pupal stages and there is increased mortality during adult eclosion which may be due to an alteration in the chitin structure of the puparium.

14P,7 Diflubenzuron As An Inhibitor of Chitin Synthesis in Manduca and Mamestra Larvae. Mitsui,T., Nobusawa, C., Fukami, J., and Riddiford, L.M. (The Inst. Physical and Chem. Res., Saitama, 351 Japan)

Diflubenzuron was found to inhibit cuticle deposition and pupation in Manduca and Mamestra last instar larvae when fed or applied topically. When the epidermis from 1 day old last instar larvae was cultured in Grace's medium in the presence of diflubenzuron, no endocuticle deposition was observed. Ecdysterone-initiated pupal cuticle synthesis was also inhibited by the compound in epidermis from wandering larvae. Microautoradiography and ^{14}C-glucosamine incorporation experiment showed the effects were due to its inhibition of glucosamine incorporation into chitin with ID_{50} of $1.1X10^{-9}$ M. When ^{14}C-glucosamine was injected into the last instar larvae, ^{14}C-UDP-N-acetylglucosamine was found to accumulate in the treated animals with the inhibitor 1.5 to 2.5 times as much as in the control animals. It shows the compound would block the terminal polymerization step in chitin synthesis. Chitin synthetase activity in cell-free extract from Mamestra larvae was measured *in vitro* using ^{14}C-UDP-N-acetylglucosamine as a precursor. The compound did not inhibit the enzyme when added to the *in vitro* system. The enzyme from the inhibitor-treated animals, however, was only one tenth as active as that from the control animals.

14P,8 THE USE OF [^{3}H]-PERMETHRIN OF HIGH SPECIFIC ACTIVITY TO INVESTIGATE ITS DISTRIBUTION, METABOLISM AND ACTION IN LARVAL AND ADULT STAGES OF THE SHEEP BLOWFLY, LUCILIA SERICATA. Botham, R.P., Hart, R.J., Nicholson, R.A., Potter, C. and Wilson, R.G. (Wellcome Res. Labs., Berkhamsted, England)

Electrophysiological examination of the action of permethrin showed a similar sensitivity of the nervous system in both adults and larvae. In toxicity tests, however, the larvae proved much less susceptible than the adults. Biochemical and autoradiographical experiments using [^{3}H]-permethrin (5 Ci/mmol) indicate that differences in penetration and tissue distribution may be important factors responsible for these results.

14P,11 ROLE OF ALGAE ON DEGRADATION OF PESTICIDAL RESIDUES IN AQUATIC ENVIRONMENTS.

Matsumura, F. (Pesticide Research Center, Michigan State University, E. Lansing, MI 48824, USA)

The nature of the factor which promotes photodecomposition of pesticidal chemicals in blue-green algae was studied. As a result of partial purification and spectroscopic studies it was identified to be small weight flavoproteins. In their presence the photodegradation of DDT, lindane, dieldrin, toxaphene, parathion and mexacarbate was greatly enhanced. The same flavoproteins were found to play a role in reductive degradation of mexacarbate, DDT, and to a lesser extent toxaphene under anaerobic condition. This reaction was promoted by exogenously added flavin cofactors. Thus, flavoproteins were found to play two distinct roles in degrading xenobiotics: as agents promoting photochemical and reductive degradation activities. Because of the biomass, the large surface area and the relative abundance of algae in many aquatic systems, algae must be considered to play important roles in pesticide degradation in the aquatic environment.

14P,12 Evidence of Resistance to Insecticides of Some Key Pests in Thailand

Sinchaisri, N., Apajirakul, T., and Noppan, V. Dept. of Entomol. Kasetsart Univ. Thailand.

An occurrence of resistance to insecticides of the economic important pests has been investigated in the diamond back moth, Plutella xylostella L., a key pest of vegetable crops and the american boll worm, Heliothis armigera Hubner, akey pest of cotton in Thailand. Laboratory test has been attempted in both species. LD50 values tested with pyrethroids showed a significant difference among the strains of diamond back moth while the tolurance was noticable in the american boll worm to toxaphene+ DDT (2:1) and carbaryl by the successive year. Further study was carried out in the diamond back moth in order to elucidate the resistant strain and the mechanism of the resistance. Additionally, in accordance with the control program, co-toxicity value of Decis + Tokuthion was more than one.

Section 15.

Pesticide Development, Management and Regulation.

15S-1,1 THE ROLE OF APPLICATION TECHNIQUES IN RESPECT TO SAFE AND EFFICIENT PEST CONTROL - INTRODUCTION.

Van Valkenburg, J. Wade, 494 Curfew St, St. Paul, Minnesota, 55104 USA

The papers in this symposium will show how novel formulation and application techniques allow pesticide operators to improve their performance. Important problems from the safety standpoint include(1) how can one reduce the number of ultra fine particles or spray droplets in the air thereby reducing drift and the possibility of breathing particles, (2) how can one reduce ground contamination when the spray target is foliage and (3) how can one reduce soil movement of pesticides. Important problems from the pesticide efficacy standpoint include (1) maximizing the retention of the pesticide on foliage in foliar applications, (2) optimizing the availability of the pesticide to the insect such that a lethal dose is available for the longest period of time and (3) decreasing the effect of the environment on the stability of the pesticide.

15S-1,2 RECENT DEVELOPMENTS IN CONTROLLED RELEASE PESTICIDES

Kanakkanatt, S. V., Division of Engineering and Science Technology, The University of Akron, Akron, Ohio, U.S.A.

The large scale use of Controlled Release Technology in pest control is relatively recent. This new technology provides a method of substantially decreasing the amount of pesticide added to the environment and remarkably increasing its efficacy. The health hazard to those handling the toxicants and the cost of application are greatly reduced. The most attractive feature of the Controlled Release Technology lies in the use of far less quantities of the pesticides than in the conventional technique and the substitution of non-persistent agents for persistent ones. The mortality of the target pest is induced through chronic exposure to ultralow concentrations of the agent; thereby, greatly reducing the contamination of the environment. Once they are released from their polymeric reservoirs, these non-persistent toxicants undergo degradation into non-toxicant materials in a relatively short time and do not leave long-term toxic residues.

The polymeric reservoir for the pesticide can take a variety of forms, such as a polymer compounded with the pesticide and cured to form a matrix; polymeric capsules, hollow fibers or stabs containing the toxicant; and polymeric backbone to which pesticidal pendant groups are chemically attached. Consequently, the mechanisms of release of the agent from these various types of reservoirs may be simple leaching, molecular diffusion or hydrolitic cleavage.

15S-1,3 THE EFFECT OF GLYCOLS ON THE HYDROPHILE-LIPOPHILE BALANCE AND THE MICELLE FORMATION OF NONIONIC SURFACTANTS.

Leszek Marszall, Pharmacy No. 09068, Rynek 12, 86-170 Nowe, Poland, and J. Wade Van Valkenburg, 494 Curfew St., St. Paul, Mn. 55104, U.S.A.

Glycols and diglycols are often used in combination with surfactants in pharmaceutical, cosmetic and pesticide formulations. These glycol solvents or additives affect the physical characteristics and performance of nonionic surfactants. The "effective" HLB of nonionic surfactants was determined by measuring cloud points, phenol indices and critical micelle concentrations. The addition of glycols to polyoxyethylated nonionic surfactants causes an increase in the values of the above parameters. The results suggest that an "effective" HLB, as measured by the phenol coefficient, etc., is of greater practical significance than a calculated HLB.

15S-1,4 Recent Development of Aerial Application Techniques in Japan

S. Yamamoto and T. Saitoh, Agricultural Aviation Association, Tokyo, Japan

In Japan, aerial application of pesticides is conducted only by helicopter. The formulation of the pesticides for use in aerial application was mainly dust in the past, but drift of dust has become a serious problem in view of environmental pollution. The application of other kinds of formulations, fine-granules, ultra-low volume spray (ULV, 1-3 l/ha), low-volume spray (LV, 8 l/ha) and high-volume spray (HV, 30 l/ha) has been investigated to solve the drift problem. The proportion of small spray droplets is closely related to the spray drift. In aerial spraying of LV and HV, water evaporation of the falling droplets is one of the important factors causing drift hazard. In order to restrain the water evaporation and increase the percentage of the spray occurring in an optimum droplet size range, a number of substances have been tested by adding to the spray liquid. Among them, sodium polyacrylate (Aron-A ^{R}) proved to be most promising. The results in the laboratory and field tests indicate that the very small droplet component is remarkably decreased and less spray drift is observed by addition of it.

15S-1,5 SPECIFIC METHODS FOR CONTROLLING DISEASES AND INSECT PESTS IN HORTICULTURE UNDER STRUCTURE.

Yakumaru,K.,and Uezima,T.(Zen-Noh Agricultural Technical Center, Higashiyahata 5-5-1,Hiratsuka-shi, Kanagawa,254 Japan)

e have been developed the low volume application method by fine dust formulations (Flo-Dust®) in the protected horticulture recently.This fine dust(under 5μm in mean diam.) is applicated in the amount of 300-500g/10a at the entrance of greenhouse by a knapsack-type power duster. It takes only about 3-5 minutes per 10a by this application method. The applicated fine dust diffuses uniformly at the every nook and corner of greenhouse and finally deposites on the surfase of plants.

We tested the control effect of salithion fine dust for green peach aphid of eggplant and chlorothalonil fine dust for anthracnose of cucumber in large greenhouse. Those fine dust were as effective as each wettable powder.

The polyvinyl chloride film as covering material was contaminated only slightly by this fine dust application. This application method is not only labor and time-saving but also safe for application workers.

15S-2,6 CHEMICAL CONTROL OF THE BROWN PLANTHOPPER WITH SPECIAL REFERENCE TO THE POPULATION DYNAMICS.

C. H. Cheng, (Chiayi Agric. Expt. Stn. Chiayi, Taiwan, Republic of China)

There are several approaches to the brown planthopper(BPH) control, but at present the only one known to effect an immediate reduction in the pest numbers involves the use of insecticides. The effectiveness of insecticide on suppressing the population of BPH is affected by various factors, such as natural property of insecticides, fomulations of the compounds, the tecniques of applications and natural enviroment of paddy fields. Most carbamates are more effective than organophosphorous compounds. Both of them generally have faster knockdown effects on the BPH but fail to kill the nymphs haching from eggs due to their short residual activity. Therefore, the pest populations are easily tecovered from the control few days after insecticidal application. On the contrary, Some chemical compounds with antifeeding on insectistatic activities reduce the insect population slowly but have longer residual activity.

Among the fomulations of insecticides commonly used, granule generally have longer effectiveness to control the population of BPH than the others. Placement of granules in rootzone area of rice plants have a longer-lasting control effect than conventional broadcasting of granules. The granules are applied to moist soil with no surface water provide more rapid and lasting control than that obtain from ordinary applications.

Spraying insecticides on the plant bases increase the effeciency by 10 to 30% as compared with those spray on the canopy. Insecticide in dust fomulation generally provides a better protection of the crop from BPH damage than that of liquid spray with especially in the late stage of the crop. Timing for insecticidal application greatly affects the control effeciency. Application of insecticide at the maximum nymphal density when the population of BPH reach an economic threshold provide a long-lasting control of the insect.

15S-2,7 PESTICIDE MANAGEMENT IN THE CONTROL OF BROWN PLANTHOPPER IN JAPAN.

Nagata, T (Kyushu National Agricultural Experiment Station, Chikugo, Fukuoka 833, Japan)

Control of the brown planthopper (BPH) is completely dependent on insecticides in Japan. All of our rice cultivars are highly susceptible to BPH. This situation is quite different from those of other Asian contries where utilization of resistant rice cultivars are playing an important role. Generally, chemical control of BPH has not been difficult so far in Japan because relatively slow developing rate of insecticide resistance in the past favoured. However, lack of ovicidal action in the insecticides necessiated frequent repeating of insecticide application because the eggs protected in the plant tissues hatch immediately after persistent effects were lost and establish insect population again. It is a problem of great concern to reduce times of insecticide application to spare labour and to avoid adverse effects caused by such a frequent application. This paper present the results of studies conducted to improve the effects of insecticide application in relation to the timing of control, estimation of persistent period of insecticide in paddy fields and sampling techniques for BPH. Added to these problems, further improvement of the efficiency of insecticide application is needed because general decrease of insecticide susceptibility in the immigrant BPH is pointed out in Japan in recent years.

15S-2,8 INSECTICIDE INDUCED BROWN PLANTHOPPER (NILAPARVATA LUGENS) RESURGENCE IN RICE.

Heinrichs, E. A., Aquino, G. B., and Chelliah, S. (Dept. Ent., Int. Rice Res. Inst., Box 933, Manila, Philippines)

Insecticide induced brown planthopper outbreaks occur in experiment station plots and in farmer's fields. Numerous insecticides which cause planthopper resurgence have been identified. Laboratory investigation indicated that sublethal rates of certain insecticide increase feeding activity, adult longevity and reproductive rate of the planthopper. In field studies degree of resurgence was related to the insecticides used, and time and method of application.

15S-2,9 PESTICIDE MANAGEMENT IN RICE INSECT CONTROL IN INDONESIA. Soekarna, Dandi (Central Res. Inst. for Agric., Bogor, Indonesia).

The average annual infested rice crop was about 1.4 miljon hectare with a loss of 16 percent. Insects responsible for the damage were primarily N.lugens and N.nigropectis, T.incertulas and T.innotata, L.acuta, O.oryzae, C.medinalis and N.depunctata. The pesticide used composed of diazinon, carbamate, fenitrothion, fenthion, chlorpyrifos, monocrotofos and recently combinations of organophosphates and carbamate, such as fenitrothion + bpmc, diazinon + bpmc, diazinon + mipc, cartap + mipc. The Pesticide Committee start with the first category of management by screening pesticides which can be evaluated for its efficacy, fish toxicity and side effects. Efficacy trials yielded recommendations on effective pesticides, proper time, dosage and method of application. Two methods of application, one based on crop age with fixed intervals and using population density as control threshold are being practised against the brown planthopper, N.lugens and the yellow stemborer, T.incertulas.

15S-2,10 Recent Chemical Control of Rice Insects in Japan with Special Reference to Mechanical Transplanting.

Kono, Yoshiaki and Sakai, Michihiko
(Res. Lab., Agr. Chem. Div., Takeda Chem. Ind., Ltd., Ichijoji, Sakyo-ku, Kyoto)

Along with distribution (88% in 1979) of mechanical transplanting of rice seedling in Japan, the application of granular insecticides into the nursery box has widely spread. This application method efficiently controls insect pests of early stage of rice plant; the first generation of the rice stem borer, the rice leaf miner, the smaller rice leaf miner, the rice leaf beetle, the rice water weevil, the smaller brown planthopper, and the green rice leafhopper, and virus and micoplasm diseases transmitted by the insect vectors; the rice dwarf, the rice yellow dwarf, the rice stripe. Chemicals (cartap, disulfoton, propaphos, and propoxur are now used) applied by this method are incorporated by rice plants after the transplanting as well as in the nursery box and then show the persistent activity. Dosage and labor are saved, reducing the environmental contaminations. Several features of this application will be reported.

15S-3,11 RECENT TRENDS IN STORED GRAIN FUMIGATION.

Bond, E.J. (Res. Inst., Agr. Canada, London, Ont. N6A 5B7, Canada)

The use of fumigants for pest control is becoming more uncertain as new information on occupational hazards and residue toxicity is made available. Some compounds have already become obsolete or are restricted because of hazards they create and those remaining are under close scrutiny for harmful effects on health or the environment. Current fumigation practices are changing with the changing attitudes towards pesticides and pest control and with new methods of harvesting and handling grain. Other methods of control, including the use of carbon dioxide, inert atmospheres, aeration and low temperatures are being developed and will replace the need for fumigants in some areas. Best control of insects in grain may be achieved by a combination of all methods of prevention and control in an integrated pest management program.

15S-3,13 FUMIGATION OF CITRUS FOR EXPORTING IN ISRAEL

Rössler, Y,, (CMBI), Agrotech. Div., 69 Haifa Rd., Tel-Aviv, Israel.)

Post-harvest fumigation of packed fruit for export in Israel is an optional and final defence measure against the Mediterranean fruit fly and various armoured scale insects. It supplements a well-designed field control program which includes chemical and biological control measures. It is implemented only according to requirements of specific Citrus importing countries as a safety measure. Ethylene-dibromide is the principle fumigant and it controls efficiently all life stages of the Mediterranean fruit fly as well as the fruit infesting armoured scales. HCN is rarely used when only scale insects are to be controlled.

The Citrus Marketing Board operates 4 modern fumigation chambers at the port of Ashdod. Their total volume is 2072 m^3 and their capacity is 23040 cases. Fumigation is carried out at rates of 14 - 16 gms./m^3 for a period of 2 - 2.5 hours. This is followed by an aeration period of 48 hours, in large fly-proof screen cages adjacent to the fumigation chambers, prior to cold-storage or shipment.

The insecticidal and phytocidal dosages of EDB are in close proximity. Peel injury is manifested in brown depression of the skin. Grapefruit is the most susceptible variety, Shamouti-oranges are less, and the Valencia lates are the most immune.

The logistics of fumigation of large amounts of Citrus fruit during a relatively short season take in account the economics as well as the insecticidal, phytocidal and toxicological aspects of such operation. During the 1978/79 season, approximatelly one-million citrus cases were fumigated succesfully with no adverse effects.

15S-3,14 CHEMICAL RESIDUES IN INTERNATIONAL TRADE. SNELSON. J.T. (Department of Primary Industry, Canberra. ACT 2600 Australia)

The continued wide use of pesticides is essential to the production and protection of the increasing amounts of food required by the rapidly increasing world population. The large scale practical use of insecticides including fumigants is one of the significant technological developments of the 20th Century. Experience has shown that various precautions are essential and must be enforced to ensure correct use and to avoid excessive residues. Residues have become one of the quality standards which are important in the marketing of food. The history of food laws, the concepts of good practices in the use of chemicals and the nature of residues will be reviewed. Residues resulting from the post-harvest treatment of fruits and vegetables are discussed in reference to the definitions of "Pesticide Residue" and "Food Additive". Methods for the detection and determination of residues are important in regulating levels of residues.

Legal limits for residues are developed by a well established scientific rationale which provides adequate assurance of sefety for consumers. The functions of national and international authorities in establishing maximum residue limits are outlined in order to provide understanding of the efforts being made to reach international agreement on residue limits to facilitate trade in foodstuffs while ensuring a high standard of public health protection. Problems encountered in international trade point to the need for still greater efforts to reach international understanding and acceptance of the need for trading partners to use approved chemicals of a nature and in a manner possibly different from domestic users.

15S-4,15 Evaluation of Pesticide Impact on the Environment. Kenaga, E. (Dow Chemical U.S.A., Midland, Michigan)

For hazard assessment of pesticides in the early stages of development of their uses, methods are needed to estimate environmental concentrations in air, water, soil, and organisms to compare with concentrations toxic to various key indicator organisms. Statistical correlations are used to estimate or predict environmental concentrations, and distribution coefficients of chemicals between various media. Monitoring and geological data are used to establish "Ballpark" determinations of the upper limits of concentrations of chemicals in various media based on environmental dilution. Correlation coefficients and regression equations are used to establish the minimum number of organisms and physical and chemical properties needed to be used along with other properties for preliminary hazard evaluation.

The predictive relationship between the toxicity of chemicals of various structures to species, whether closely related or not, and between acute and chronic toxicity are discussed. Comparisons of concentrations of widely used chemicals occurring in water and concentrations toxic to a wide variety of organisms is shown.

15S-4,16 PESTICIDE SAFETY FACTOR IN THE DEVELOPMENT OF NEW PESTICIDES. Kimmerle, G. (Mobay Chem. Corp., Stanley Res. Ctr., Stilwell, KS, USA)

The estimation of acceptable exposure limits for chemical substances is common to many public environmental health fields (e.g. TLV, MRL). Using the assessment of the total toxicological data base, these limits are essentially the product of informed judgement. This judgement is expressed in the selection of a safety factor, which mainly is an aid in the extrapolation from animal to man. Examples of using safety factors to establish acceptable levels in various countries and international organizations are given. The large amount of toxicological and exposure data influencing safety factors is discussed. Like all risk assessment estimations, the safety factor is subject to revision, either when additional data becomes available, or when data interpretation changes with increasing scientific knowledge.

15S-4,17 Mutagenicity Screening Studies on Pesticides. Y. Shirasu(Inst. of Environm. Toxicol., Tokyo,187, Japan)

Microbial mutagenicity screening studies employing Ames type tests have been done on 198 pesticides including 67 fungicides, 62 insecticides, 67 herbicides, and 2 plant growth regulators. Our screening studies revealed mutagenicity in the following 20 pesticides: Captan, Captafol, Dexon(DAPA), Dichlorvos, Folpet, HEH, NBT, NNN, Vamidothion, DDC, Ferbam, Ziram, TTCA, TMTD, EMSC, Bis-Dithane, Dichlofluanid, ETU, DBCP and EDB. Cytogenetic and dominant lethal studies conducted on Captan and ETU were negative. Positive results were obtained in the cytogenetic and dominant lethal studies in mice given combined oral administration of ETU and $NaNO_2$. Our recent sister chromatid exchange (SCE) studies revealed the activities in Capatan, Captafol, EDB, DBCP, HEH, DDVP, Vamidthion, DAPA and N-nitroso-ETU. Our latest dominant lethal studies on DBCP and EDB discovered that DBCP gave positive results in rats but not in mice, although EDB was negative in these animals.

15S-4,18 SURVEY OF ENVIRONMENTAL CONTAMINANTS. Fishbein, L. (National Center for Toxicological Research, Jefferson, Ark. 72079 USA)

There is an increasing awareness of the potential environmental and health hazards of trace levels of pesticides, their trace impurities as well as their metabolites and/or degradation products. Hence, there is a concomittant need to develop and refine requisite analytical and toxicological methodologies for the detection and estimation of these agents as well as their biological and toxicological activity. The major objectives of this survey are to highlight several of the newer advances in the analysis of trace impurities and of pesticides *per se*. Emphasis is focused on the analysis of trace levels of nitrosamines and chlorinated dibenzo-p-dioxins, particularly 2,3,7,8-tetrachlorodibenzodioxin (TCDD). Analytical techniques to be discussed include: detection of thermal energy analysis, low-temperature and room-temperature phosphorescence analysis, ^{31}P-Fourier Transform-NMR and radioimmunoassay.

15S-5,19 INSECTISTATICS IN PEST MANAGEMENT

Levinson, H.Z. (Max-Planck-Institute of Behavioural Physiology, 8131 Seewiesen, West Germany)

For more than a century the strategy of insect control has been based on rapid kill of the target species in maximal numbers by residual and volatile insecticides which usually intoxicate one or more developmental stages. Nonselective intoxication of harmless and beneficial species, development of insecticide-resistant strains and environmental pollution are the main disadvantageous byproducts of insecticidal treatments. A new approach to pest management involves the causation of insectistasis (stasis = stagnation), i.e. decimating an insect population below its level of economic damage and thus avoiding some of the above shortcomings.

When formulated as insectistatics (= agents causing insectistasis), food attractants, repellents, pheromones, hormone mimics, nutrient and metabolite antagonists can be employed for the integrated manipulation of pest populations. As many hormone mimics affect the insect's life cycle only during certain susceptible periods, the application of such agents will suppress target populations rather progressively. Different types of attractants may be profitably formulated with supplementing sensory stimuli in baits containing immobilizing, sterilizing, pathogenic or toxic agents, while repellents can be superimposed as a barrier against insect attack.

Mass trapping by attractant baits can produce insectistasis provided the population density is relatively low, whereas disruption of mating communication by overdosed pheromones or orientation inhibitors can suppress insect populations also at higher density levels. Insectistasis can be achieved by continual supervision due to trapping with attractant devices in combination with customary control measures timed in accordance.

15S-5,20 EFFECT OF ISOPROTHIOLANE ON PLANTHOPPER POPULATION

Fukada,M.,Sugimoto,T. and Taninaka,K.(Nihon Nohyaku Co.,Ltd., Osaka,586 Japan)

A rice-blast fungicide,isoprothiolane(diisopropyl 1,3-dithiolan-2-ylidene-malonate,IPT) was incidentally found to be also effective in reducing the population density of rice planthoppers,*Nilaparvata lugens* and *Sogatella furcifera*, in the field by submerged application for about one month at a.i.360-480g/10a. Although IPT is neither ovicidal nor directly toxic to adults of *N.lugens* or *S.furcifera*, it shows characteristic larvicidal action; the larvae, just after hatching, reared on IPT-treated rice plant, begin to die 6-7 days and some of the larvae are dead with abnormalities in moulting.

Other effects such as shortening of longevity and suppression of oviposition were also observed in adults of *N.lugens* that had been reared on IPT-treated plant since earlier instar stage. The suppression of population growth of planthoppers by IPT in the field seems to depend on mutiplication of these effects.

We are sure that IPT is available to control planthoppers, though it does not exert eradicative action to them.

15S-5,21 CHIRAL INSECT PHEROMONES --- SYNTHESES AND BIOLOGICAL ACTIVITIES.

Mori, K. (Dept. Agric. Chem., Univ. Tokyo, Tokyo, 113 Japan)

Syntheses and biological activities of chiral insect pheromones will be reviwed with some recent examples of stereocontrolled syntheses.

15R-1,1 INSECTICIDAL ACTIVITY OF S-2703 ISOMERS.

Hirano,M., Yano,T. and Fujita Y. (Sumitomo Chemical Co., Ltd., Takarazuka, Hyogo, 665 Japan

S-2703 (α-cyano-3-phenoxybenzyl chrysanthemate) showed high insecticidal activity (Matsuo et al, 1976), and this compound laid the foundation of a series of synthetic pyrethroids such as cypermethrin and fenvalerate. The authors studied the insecticidal activity of S-2703 isomers. As the result, the insecticidal activity of (+)trans isomer was superior to that of (+)cis isomer against Musca domestica and Blattella germanica, but it was inferior to that of (+)cis isomer against Culex pipiens pallens and Spodoptera litura. S-2703 and its isomers showed high efficacy against lepidopterous larvae in field, and they were not so persistent as cypermethrin and fenvalerate.

15R-1,2

ACARICIDAL PROPERTIES OF PHENOTHIOCARB, ANEW ACARICIDE

H.Ogawa, T.Hirano, Y.Moriichi, T.Miyaki, H.Koyasu, H.Shimizu, K.Fujimori and M.Tamaru
(Life Sci. Res. Inst., Kumiai Chemical Industry Co.Ltd., Shizuoka,439 Japan)

Phenothiocarb,S(4-phenoxybutyl)-N,N-dimethylthiolcarbamate,has been developed by Kumiai Chemical Ind.Co. Ltd.,under the code No. of B1-5452 as a new acaricide with low toxicities to mammals, fish and beneficial insects. It is effective on mites belonging to Panonychus. The LC-50 values of phenothiocarb for eggs,protonymph, deutonymph and female adults of P.citri were 8.9, 12.6, 15.2, 32.8 and 81 ppm respectely. The acaricidal activity of phenothiocarb varied due to the temperature tested. The activity at low temperature(15°C) was higher than that at high temperature(30°C). Phenothiocarb was very effective not only sensitive but also on dicofol or benzoximate resistant strain of P.citri. In the field trials conducted for the past 3 years, phenothiocarb sprayed at the concentration of 233-500 ppm showed an efficacy as good as dicofol and amitraz for the control of citrus red mite. The control effect was better in autumn than in summer field trial. No phytotoxicity was found at practical dosage on citrus trees such as satsuma orange, navel, summer orange and lemon.

15R-1,3

THE MODE OF ACTION OF FENPROPATHRIN ON PANONYCHUS CITRI AND TETRANYCHUS CINNABARINUS.

Kasamatsu, K. and Fujita, Y. (Sumitomo Chemical Co., Ltd., Takarazuka Hyogo, 665 Japan)

Fenpropathrin (α-cyano-3-phenoxybenzyl-2,2,3,3-tetramethyl cyclopropanecarboxylate) is a promising candidate acaricide. The authors studied its mode of action, and found that it possessed high acaricidal efficacy against newly hatched larvae, nymphs and adults of P. citri and T. cinnabarinus, though low in ovicidal activity. Fenpropathrin showed quick paralyzing action at the concentrations above 10 ppm and excellent repellency at less than 1 ppm. When fenpropathrin was applied at 1-5 ppm, the number of eggs laid was remarkably reduced and feeding inhibition was also observed, which seemed related to the paralyzing action. Fenpropathrin showed a negative temperature coefficient of acaricidal efficacy.

15R-2,4

AC-217,300, A PROMISING NEW INSECTICIDE FOR USE IN BAITS FOR CONTROL OF THE BIG-HEADED ANT, PHEIDOLE MEGACEPHALA (FABRICIUS) IN PINEAPPLE.

Su,T.H., Beardsley, J.W. and McEwen, F.L. (Dept. Ento., Univ. of Hawaii, Honolulu, Hawaii 96822)

When used in a corn grit-soybean oil bait at 1500-7500 ppm, AC-217,300 (2(1H)-Pyrimidinone,tetrahydro-5, 5-dimethyl-,[3-[4-(trifluoromethyl)phenyl]-1-[4-(trifluoromethyl)phenyl]-2-propenylidene] hydrazone) provided control of the big-headed ant comparable to that with mirex bait at 3000 ppm when the baits were broadcast at 2.24 kg per hectare in old and new pineapple plantings.

15R-2,5

THE COMPATIBILITY OF A RICE PADDY MODEL ECOSYSTEM TO EVALUATE THE DEGRADABILITY OF THE PESTICIDES. Hsu, E. L. and Hsu, S. J.(Dept. of Plant Path.& Ent., N.T.U., Taipei, R.O.C.)

The distribution and fate of eight ^{14}C radiolabeled insecticides DDT, r-HCH, aldrin,dieldrin; carbaryl, MTMC; malathion, parathion were evaluated in a laboratory rice paddy model ecosystem. The radiolabeled products were transfered through the food chains, e.g., rice, grasshopper, brown planthopper, wolf spider, alga, duckweed, snail, water flea, mosquito, fish. The high values for ecological magnification and the low biodegradability indices for the organochlorine pesticides are in significant contrast to the low ecological magnification values and high biodegradability indices found with orgnophosphorous and carbamate insecticides.

The rice paddy model ecosystem, with the use of radiolabeled insecticides, is the most convenient tool for studying the fate and environmental effects of pecticides to be used in rice paddies and this technology can be used in every laboratory.

15R-2,6

Pesticide Monitoring in Agricultural Settlements in Israel.

Rubin, A. (Nature Reserves Authority, Tel Aviv, Israel)

Since '74 a pesticide monitoring project has been carried out in ca. 1000 agricultural settlements in Israel. The purposes of the project were to (i) limit the number of storage facilities being maintained for the security & economic benefit of the farmer, and (ii) Increase the amount of recycling employed in the means of pesticide packaging. The procedures in the project were to (i) conduct training courses & hold exams for pesticide staff in agr. settlements, preliminary to the issuance of permits to managers of storage houses; (ii) inspect agr. airstrips and distances between cotton & houses or water (at least 120 m) (iii) inspect agr. spray companies & exterminators: (iv) forbidden pesticides as endrin aldrin & dieldrin or old ones are collected from storage houses to a central place where they are neutralized. Today 2/3 of the pesticide storage houses are according to law (17% in '74).

15P,1

TOXICITY OF NEW INSECTICIDAL AMIDES FROM PIPER NIGRUM L. TO ADZUKI BEAN WEEVIL. Nakayama, I., Miyakado, M., Fujita, Y. and Yoshioka, H. (Sumitomo Chem. Co. Ltd., Takarazuka, Hyogo, 665 Japan)

Three unsaturated isobutylamides, pipercide ((2*E*,4*E*,10*E*)-*N*-isobutyl-11-(3,4-methylenedioxyphenyl)-2, 4,10-undecatrienamide), dihydropipercide ((2*E*,4*E*)-*N*-isobutyl-11-(3,4-methylenedioxyphenyl)-2,4-undecadienamide) and guineensine ((2*E*,4*E*,12*E*)-*N*-isobutyl-13-(3,4-methylenedioxyphenyl)-2,4,12-tridecatrienamide) from the fruits of *P. nigrum* L., revealed notable toxicity and paralyzing action to the adzuki bean weevil, *Callosobruchus chinensis* L.. A mixture of the three amides in a 1:1:1 ratio showed the most potent synergistic action and its toxicity was as active as pyrethrin. Other biological aspects will be discussed.

15P,2

LARVIN^{TM} thiodicarb insecticide - introducing a new product from Union Carbide Agricultural Products Co., Inc. B. S. Cheary and R. G. Haines (Union Carbide Ag. Products Co., Jacksonville, Florida)

LARVIN^{TM} 500 thiodicarb insecticide is an aliphatic methyl carbate which is formulated as a 44% aqueous flowable containing 500 grams active ingredient per liter of formulation.

LARVIN has been tested worldwide and has shown excellent activity against many of the economic lepidopterous pests attacking major crops such as cotton, soybeans and corn, as well as fruit, vegetables, pasture, sugarcane, tobacco, sugar beets, ornamental plants, forest and rangeland. LARVIN at rates varying from 0.2 to 0.7 kg ai/Ha has proved particularly effective against such cotton bollworm pests as the Heliothis complex (H. armigera, H. zea, H. virescens, H. punctigerda), Diparopsis spp., and Erias spp., and foliage feeders such as Spodoptera spp., Plusia spp., Laphygma spp., Agrotis spp., Chilo spp. and other pests such as cotton stainers, cotton leafperforators and cabbage loopers. Environmental impact, based on avian, fish and invertebrate toxicity data is predicted to be negligible. Data from the major cotton-growing states in the U.S. indicate that LARVIN at 0.5 kgs. ai/Ha has a much lower impact upon beneficial insects such as Geocoris spp., Nabis sp., Orius sp., spiders, parasitic wasps and other beneficial species, than many of the leading cotton insectitices.

LARVIN is a cholinesterase inhibitor and mode of action is primarily by stomach poisoning. The physicochemical properties are such that the active agent will degrade rapidly in soil, water and other substrates. Acute toxicities of the technical are: Oral LD_{50} = 248 mg/kg/bw (rat); Dermal LD_{50} = >6300 mg/kg/bw (rabbit); inhalation LC_{50} = >2040 mg/liter (4 hr. rat).

LARVIN 500 when used at rates varying from 0.2 to 0.7 kgs. ai/Ha has proven to be very effective in integrated pest management programs. The adverse effects of LARVIN on beneficial insect populations are less than half that of pyrethroids at equivalent effective rates.

15P,3

BIOLOGICAL ACTIVITY OF SOME NOVEL SYNTHETIC PYRETHROIDS DERIVED FROM VALINE. Staal, G.B., Henrick, C.A., Cerf, D.C. (Zoecon Corp., Palo Alto, Calif., USA)

Some analogs of fluvalinate (ZR-3210, α-cyano-3-phenoxybenzyl 2-(2-chloro-4-trifluoromethylphenylamino)-3-methylbutanoate) are stable pyrethroids of high activity against many agricultural pests. Several of these analogs display unexpectedly high activity on spider mites, superior to the mite activity of other stable pyrethroids such as permethrin and fenvalerate. Fluvalinate shows a negative temperature-activity correlation from 15° to 30°C, but the activity does not decrease further above 30°, and at 37°C the LD_{50} on Heliothis virescens is lower than that found for permethrin and other pyrethroids.

15P,4

THE MERITS AND REQUIREMENTS FOR PESTICIDE REGULATION IN DEVELOPING COUNTRIES. De Lima, C.P.F. (National Agric. Labs., Box 14733, Nairobi, Kenya)

In the developing world pesticides are used mainly for the protection of cash crops like coffee, cotton, sugarcane etc. However, with rapid improvements taking place in small-scale subsistence farming, pesticides are increasingly being used on food crops. Over the past few years, a wide range of pesticides has been made available, and it has become increasingly necessary to introduce some form of control over the distribution and use of these products in developing countries. Official control is important because, by and large, the end user of the product (the peasant farmer) is not literate and unable to evaluate the side-effects of the chemical to himself, his livestock, his crop, the environment, and to the consuming public.

15P,5

THE CHIRALITY-ACTIVITY RELATIONSHIP OF OPTICALLY ACTIVE CYCLODIENE INSECTICIDES

Miyazaki, A., Sakai, M. and Marumo, S. (Osaka Agr. Res. Cent., Osaka, 583 Japan)

Both enantiomers, optically pure, of cyclodiene insecticides such as chlordene (1), chlordene epoxide (2), cis- and trans-chlordanes (3 and 4), heptachlor (5), heptachlor epoxide (6), 2-chloroheptachlor (7) and 3-chloroheptachlor (8), were synthesized via optical resolution of racemic 1-hydroxychlordene (9) as a diastereomeric mixture of 3β-acetoxyetienyl esters. The absolute stereochemistry of these synthetic insecticides was determined by circular dichroism of dechlorinated tricyclic ketone derivatives of (+)- and (-)-9. Insecticidal activity of the enantiomers of these compounds, except chlordanes, was measured on male adults of German cockroaches. (+)-1 and (-)-2 exhibited much stronger activity than the corresponding antipodes, while a slight difference was observed between the enantiomers of 6 and 7. The racemic form of 5 exhibited the stronger than its either enantiomers. Neither optically active nor racemic 8 were active.

15P,6

THE EFFECTS OF SINTER AS SOIL POLLUTANT ON SOME SPECIES OF INSECTS.

Simova,D.,Krnjaić,S.and Krnjaić,Dj. (Agricult.Faculty, Beograd, Yugoslavia)

In the broader surroundings of the industrial plant of magnesite in the region of Kraljevo, Yugoslavia, aerosol is being emitted containg caustic dust or sinter (MgO 69.8%; Fe_2O_3 8.6%; CaO 4.3%; SiO_2 4.0%; Al_2O_3 0.2%, residue after ignition amounts 13.1% and the Ph 10.6), showing a harmful effect for the living world and soil. In order to ascertain these harmful effects of sinter on the living world, a laboratory study was carried out on the effects of this pollutant on some insect species which formerly inhabited the endangered area.Among the examined species there were Mamestra brassicae L., Hyphantria cunea Drury., Portetria dispar L., Doryphora decemlineata Say and some other species.

It was established that addition of differentiated quantities of sinter to the food (natural or artificial nutritive substrate) caused disturbance in the diet of the examined species, causing further disturbances in the growth and metabolism of these species. Similar effects were observed after an application of the aqueous extract from the soil which was nearest to the source of pollution.

15P,7

STRUCTURAL CHARACTERISTICS OF ARTHROPOD POPULATION IN THE SOIL EXPOSED TO POLLUTION FROM AIR.

Krnjaić,S.,Simova.D. and Krnjajić,Dj.(Agricult.Fac.Beograd,Yugoslavia)

Considering as pollutants of the natural and man's environment all those processes that interfere with the condition and functions of living organisms and their environment, a study was carried otu of the structural characteristics of the Arthropod population in the soil which has been exposed to the pollution from the air. As a rule such are the soils occurring in the areas of industrial plants which do not dispose or dispose subefficient systems for purification of smokes or emissive gases, mineral particles, etc.

In such an area in Yugoslavia (Kraljevo) which has for many years been facing the problem of soil pollution by the fine particles of magnesium ore (sinter), drastic changes of the population of Arthropods were established in the soil, preceded by the corresponding changes of macrovegetation. In the locality which was the nearest to the source of pollution, single specimens of the following families were established: Scarabaeidae, Elateridae, Pyralidae and Formicidae. Moving away from the source of pollution the population of Arthropods was becoming richer and more complex. In the locality 2, which was more distant from the source of pollution, representatives of 13 families were recorded, at the margin of the pollution zone (locality 3) 19 families and outside it 24 families. The number of Arthropods was increasing form 201.3 (locality 1) to 406.2 individuals per sq.m. outside the zone of pollution. In summary it was concluded that the decreasing gradient of pollution was followed by occurrence of more complex and more abundant population of Arhtropods.

15P,8 Pesticides for termite control in Egypt as a model for arid ecosystems

A. Maher Ali, Agriculture College, Assiut University, Egypt.

Type of termite infestation in houses in arid and in flood devastated areas is demostrated. The strategy for pesticide application is being proposed for arid ecosystems. Adopted methods in both US and Western Europe for evaluating pesticides are being evaluated to suit the arid ecosystems. Novel approach to control sub-terr anean termites with the bait block is being considered.

Section 16.

Social Insects and Apiculture.

16S-1,1 *VARROA JACOBSONI* AND ITS CONTROL IN JAPAN

Sakai, T. and Takeuchi, K. (Inst. Honeybee Sci., Tamagawa Univ., Machida-shi, Tokyo 194 Japan)

The *Varroa* mite on *Apis mellifera* was first found in Japan in 1950's. At Tamagawa University, the mite was seen parasitizing *Apis cerana japonica* in 1957. The damage spread rapidly all over Japan owing to the migratory beekeeping while no effective control was taken against the sudden emergence. A few kinds of sulfur containing acaricide (mainly smoking agents) were sold and the control was carried on a large scale by beekeepers. At that time, *Apis mellifera* were greatly damaged not only by the mite but also by the drugs. Empirical management settled after several years of experiences. Nowadays still 100 % beekeepers suffer from the mite especially when they are idle for preventing it. An extent of damage on a colony by the mite fluctuates depending on conditions inside and outside of the colony.

The drug resistance of *Varroa* has been discussed and some beekeepers use several drugs rotationally to avoid it, although no specific results were established by researches on the problem of resistance. Mainly beekeepers practice (smoke or spray) in October to November when the parasite is easily noticeable, February to March when bees begin to increase, and summer time when the mites linger their increase. Some researchers are beginning to notice the effect of other chemicals or physical methods.

From the point that this mite is prevailing more and more in other parts of the world, we should consider some international co-operation and exchanges so that effective control measure will be produced.

16S-1,2 Varroa jacobsoni and its control in the FRG.

N. Koeniger, W. Ritter and F. Ruttner, Inst. f. Bienenkunde, Im Rothkopf 5, 6370 Oberursel,W.Germany

In 1977 Varroa jacobsoni was discovered in an area (20 x 50km) in Western Germany. During the following years some of the recommended acaricides were tested (Folbex, Sineacar, Phenotiazin, Var ostan and Kelthane). After every treatment a representative group of bee colonies was controlled by washing all bees in petrol which led to an exact determination of the remaining mites. The results were not satisfactory because only 20%-80% mites were killed by the tested chemicals. So alltogether with the mites which were inside the capped brood cells and which therefore were protected against the effect of the applied chemical, the survival rate of Varroa under normal field conditions was between 50% and 95%. In 1979 two different approaches were taken: 1. Search for acaricides, which are constantly effective in a bee colony over an extended period (at least longer than 11 days, the duration of cell capping). 2. Development of biological methods for Varroa control which are effective in combination with a chemotherapie or even alone. The results of these experiments depend on the question wether the treated colonies come through the winter 1979/80, and they will be presented only at the ICE.

16S-1,3 APPLICATION METHODS AND EFFECTS OF GUBITOL FOR CONTROL OF HONEYBEE MITE (VARROA JACOBSONI OUDEMANS) IN TAIWAN.

Ho, K. K. and An, K. (Dept. of Plant Path. & Ent., National Taiwan Univ., Taiwan)

Gubitol 51% (0, 0 Diethyl-0-(3-Chloro-4 methyl-7-Coumarinyl) - phosphorothioate) wettable powder can be used as control agent for honeybee mite (Varroa jacobsoni Oudemans) in Taiwan. 25-30 ml of 1000 X dilution per each frame twice with one week interval in Spring & Fall is quite sufficient. The Gubitol will cause a relative toxicity to young stages of honeybee, direct treat the chemical to cells, the mortalities of eggs and larvae are 29.2% and 57.5% respectively. Compare the mortalities of uncealed stages (eggs and larvae) of honeybee in different application methods, the vertical spraying method is 23.6% and the oblique spraying method is 6.9%.

16S-1,4 STUDIES ON NOSEMA DISEASE. I. THE SEASONAL VARIATIONS OF NOSEMA APIS ZANDER OF HONEY BEE (APIS MELLIFERA) IN TAIWAN. An, K. and Ho, K. K. (Dept. of Plant Path. & Ent., National Taiwan Univ., Taiwan)

Sampled 20 bees from 4 hives every month from north, west, south and east Taiwan, examined microscopically for nosema since July 1977 to June 1979. Maximal infections occurred in the spring and autumn. Minimal infections usually occurred in winter.

Infections could be found at all apiaries throughout the experiment. Weather and climate are very important factors influencing the levels of infection.

16S-1,5 CONTROL OF CHALKBROOD DISEASE OF HONEY BEES, APIS MELLIFERA L.: DIFFICULTIES AND POSSIBILITIES. Gilliam, M. (USDA, C. T. Hayden Bee Res. Center, Tucson, Arizona 85719, USA)

Chalkbrood is a disease that affects honey bee brood and is caused by the fungus Ascosphaera apis. Diseased larvae become mummified and are found at the hive entrance, on the bottom board, and in the cells of infected colonies.

Chalkbrood has been reported from Europe for many years. However, it was not found in honey bees in North America until 1968 and since that time has become widespread in the U.S. and Canada. Previously, the losses caused by the disease were not considered serious enough to justify research on treatment. However, the increase in the incidence and severity of chalkbrood has prompted searches for control measures.

Attempts to control the disease with various chemicals have generally been unsuccessful because of the toxicity of the chemicals to bees, the fact that many of the chemicals were not acceptable to the bees, and the time and effort required to disinfect all parts of the hive. The use of ethylene oxide fumigation and the selection and breeding of bees that rapidly remove the diseased larvae seem to be the most promising means of controlling chalkbrood. Other control methods include requeening diseased colonies, destroying mummies that collect at the entrance and on the bottom board, and replacing combs or comb sections that contain large numbers of mummies.

16S-1,6 CONTROL OF AMERICAN FOULBROOD. Shimanuki, H. (Bio. Bee Lab, USDA, Beltsville, MD 20705 USA)

American foulbrood disease caused by Bacillus larvae is one of the most dreaded bee diseases of honey bees. The control of this disease as practiced in the United States have included the shake treatment, development of American foulbrood resistant stocks, legal methods (inspection and quarantine), destruction of bees and equipment, disinfection of hive equipment and the use of drugs and antibiotics. In the United States, sodium sulfathiazole is no longer approved for the prevention and control of bee diseases. Today Terramycin^R (oxytetracycline) is the only material approved by the Food and Drug Administration for use in colonies of honey bees. As a result of inspection and foregoing control methods included the use of antibiotic extender patties, ethylene oxide fumigation and the combination of antibiotics and fumigation.

16S-1,7 THE BEEWOLF (PHILANTHUS TRIANGULUM) A PEST OF HONEYBEES (HYMENOPTERA, SPHECIDAE).

Simonthomas, R.T. and Simonthomas, A.M.J. (Pharmacological Laboratory, University of Amsterdam 1093 KP Amsterdam, Netherlands)

The diggerwasp that is commenly known as the beewolf has been a pest in temperate Europe occasionally in the past. In Mediterranean countries the beewolf is seemingly checked by its monophagous parasitoid Hedychrum intermedium Dahlbom. The beewolf is a solitary wasp that digs its burrow as a rule near the parental one. In this way widely scattered pseudo-colonies arise which use only a fraction of the area that is suitable for breeding. The beewolf collects honeybees from flowers as food for its offspring. As a large beewolf population can be a serious threat to apiculture many control measures have been attempted, within the constraint that spraying usually is incompatible with beekeeping. The rather deeply buried breeding cells are quite inaccessible to any way of control. Alternatively, two control measures have been used successfully against the adult wasps. Straightforward netting of the wasps, if done very conscientiously at the pseudo-colonies, and during the maxima of daily activity proved very successful. Because of the beewolfs monophagous nature temporarely removal of the beehives is also possible.

16S-2,8 DIFFERENTIATION, MATURATION AND FECUNDITY OF REPRODUCTIVES IN TERMITES. A REVIEW.

Noirot,Ch. (Lab.Zoology - Univ.Dijon, 21100 Dijon, France).

In the termite societies, the reproduction may be studied from several points of view.

1) The determination of an individual for its development in a sexual vs.a neuter caste. A genetic sex-related bias is evidenced in very peculiar cases only ; the determination for the primary reproductives (imagoes) occurs at different developmental stages, very early in the more evolved species ; the origin of replacement reproductives varies according to the species, their determination seems always very late. The social (pheromone, nutrition) and environmental (seasonal cycle) factors remains poorly understood , as do the physiological mechanisms (neuroendocrine). However the hormones evidenced in the queen (juvenile hormone, ecdysone) and transferred to the eggs may play some part on the caste determination, at least in higher termites.

2) Once differentiated, the alates cannot mature in the society, except in special circumstances.This inhibition seems related to the crowding and possibly an action of the functional reproductives (pheromone ?).It is normally removed by the swarming, the most important part being the isolation in pairs.

3) During the evolution of the Isoptera, the fecundity of the queen increased tremendously : the ovarioles became more and more numerous, and their maturation in the more evolved species is only possible by the progressive and coordinated growth of the abdomen (physogastry).Additional strategies are related with the different types of formation of the replacement reproductives,sometimes utilized for the multiplication of the colonies.

16S-2,9 REGULATION OF WORKER AND QUEEN DEVELOPMENT IN ANTS WITH SPECIAL REFERENCE TO REPRODUCTION AND COLONY DEVELOPMENT

Buschinger,A. (Zool.Inst., Techn.Univ., D-61 Darmstadt, Germany)

A review shall be presented concerning mainly two aspects of reproduction and colony development in ants. These are: 1st The different mechanisms involved in caste determination. Genetic predetermination, food, worker number, season, pheromones etc. may control, in different ant groups with variable significance, the rates of queen and worker production. 2nd: The social organisation of different kinds of ants, which reflects various strategies of colony reproduction, combined with highly different ratios of queen and worker production. This shall be demonstrated with selected examples of monogynous, polygynous and polydomous societies.

16S-2,10 DEVELOPMENT AND FUNCTIONS OF CASTE DIFFERENCES IN LASIOGLOSSUM ZEPHYRUM

Michener, C.D., (Dept. Ent., Univ. Kansas, Lawrence KS 66045, U.S.A.)

Caste determination in this primitively eusocial bee occurs in the adult stage. Probably all females are potentially able to develop into any caste. Older and larger bees are more likely to become queens than younger or smaller bees; age has more effect than size. Size is influenced by cell size and amount of food provided, these things being influenced negatively by temperature and day length and positively by mean size and number of bees in the colony.

Queens inhibit ovarian development of workers, probably at least in part by frequent nudging and constant activity. There is no evidence of pheromonal caste control. Mating is not necessary for a bee to become a queen. Artificial colonies with an unfertilized queen and fertilized workers function normally (but produce mostly male offspring). Queens can inhibit mating by associates, even when the latter are in the field; yet within hours of removal of a queen, her workers will mate.

Ovarian size in a colony varies from maximum (queen) to minimum (principal forager), with the principal guard's ovaries usually being second largest. Perhaps this bee is the guard because its ovarian condition makes it the most nudged bee, nudging serving to keep it at the nest entrance and to traumatize it so that its ovaries do not further enlarge. The bee most likely to replace a queen is not the guard but an unspecialized bee with the third largest ovaries.

Males are repulsed by most females, who are either workers or have already mated. Individual females have different odors which males remember; males tend not to waste time on nonreceptive females. These individual odors may be different than those by which guards recognize their nestmates.

16S-2,12 PHYSIOLOGY AND BEHAVIOUR OF NON-REPRODUCTIVE AND REPRODUCTIVE WORKERS OF A.M.CAPENSIS.

Velthuis,H.H.W. (Labor.of Compar.Physiol.-Univ.of Utrecht, N-3572 LA Utrecht,Netherlands) and
Ruttner,F. (Inst. f.Bee Research, Univ.of Frankfurt, D-6370 Oberursel,Germany)

Worker honeybees of the race *Apis mellifera capensis* may be considered as intermediates between the queens and workers of other races of honeybees. If such a worker is introduced into a colony or cage containing queenless workers of *A.m.carnica* (expts. in Oberursel) or *A.m.mellifera* (expts. in Utrecht) it develops into a queenlike laying worker (false queen) within 7-10 days. A court is formed around the *capensis* worker within 4 days. The false queen may continue egg laying for 3-5 months provided her brood is replaced by that of the nursing race. Egg production may be considerable but is very much dependent on number and age distribution of the host race and the physiological condition of the latter.

Within a queenless group of *capensis* the development and characteristics of laying workers are not different from these in other races. Apparently the development of the false queen is dependent on social factors acting in the adult stage. The *capensis* worker is known to produce 9-oxo-decenoic acid, one of the queen substances, in her mandibular glands. In addition we may report the presence of 9-hydroxy-decenoic acid, also known as a queen substance, and some more homologues.

Behavioural observations on the ontogeny of the laying worker suggest that communication between workers determines the food flow during trophallactic contacts. Whereas some bees mainly offer food others mainly beg and receive. The dominance of the latter ones in these contacts, probably depending on the pheromonal blend from their mandibular glands, may subsequently lead to their physiological change into a false queen. The same degree of dominance is held responsible for their increased longevity.

16S-2,13 PHYSIOLOGY OF DEVELOPMENT AND REPRODUCTION AND ITS CASTE SPECIFIC CONTROL IN QUEEN BEES

Engels, W. (Institute of Biology III (Zoology), Univ. of Tübingen, D-74 Tübingen, Germany)

Queen determination in bees depends on trophogenic factors which are probably quantitative . In Melipona this mechanism of caste development seems to be underlayered by a genetic predetermination. Apparently the trophic situation in a critical period of larval development is acting on the endocrine system. A high juvenile hormone titre arises in the case of queen formation. The subsequent caste specific differentiation of queen characters depends on a sufficient level of juvenile hormone, which also can be experimentally established by hormone application. In many insects juvenile hormone is functioning as a female sex hormone. In adult bees it is stimulating vitellogenin synthesis and yolk uptake into the growing oocytes in the queen. On the other hand, allatectomy only slightly decreases vitellogenin production and does not inhibit initiation and continuation of egg formation. Precocene application results in a more pronounced decrease of vitellogenin synthesis. Juvenile hormone therefore triggers both development and fertility in the physiology of the queen caste. But the occurrence of reproductive females as well as their egg - laying activity in eusocial bees is controlled by the colony. This can be described as a social conditioning of the reproductive capacity.

16S-2,14 SPECIAL REPRODUCTIVE FEATURES OF THE AFRICANIZED HONEYBEES OF SOUTH AMERICA WITH RESPECT TO THEIR SPREAD OUT.

Martinho,M.R.,Gonçalves,L.S., and Kerr,W.E.(Univ.S.Paulo-Ribeirão Preto-SP.Brazil)

This paper refers to several data on reproductive features of the africanized honeybees and mainly to field observations on the competition between africanized and italian drones descending from queens and workers in free matings with queens and few considerations on kinship among the bees.Kerr et al (1962) demonstrated that in Melipona quadrifasciata the queens mate with one drone each. In Apis mellifera Adams et al (1977) demonstrated that a queen is able to mate with as many as 17 drones what represent a very interesting exception to the "one queen- one male" rule among the highly social bees.Taber (1955) , Koehler (1962), Jordan (1967) and Martinho (1979) showed that the spermatozoa of each drone make aggregations or "sperm packages" inside the queens' spermatheca.This occur also in natural mating.The results of these authors show that,notwithstand the queen of Apis having mated with as many as 17 drones, the offspring of those queens in a given moment very frequently are daughters of only one or two fathers.We think that this phenomenon occurs due the fact that the sperms do not mix in the queen's spermatheca.In controlled natural matings in a sugar cane field with 200 Km^2 of area free from bees 7 groups were prepared to test the competition among drones.The results showed advantage of the africanized drones over the italian drones in all groups, no mather they were sons of queens or of workers what can be the responsible for the rapid spread of the africanized bees out of South America. . It was also concluded that sons of workers born in worker cells show no difference in flight behavior when compared to sons of queens born in drone cells. Thus, the egg-laying workers play a very important role in the phenomenon of free mating since they represent an important source of genes transmitted to subsequent generations by the drones. (Project supported by CNPq (PIG), USP and VFV.)

16S-3,15 ON THE BIOLOGY OF BELONOGASTER (POLYBIINI, VESPIDAE). PARDI, L. and MARINO PICCIOLI, M.T. (Ist. di Zool. Univ. di Firenze, 50125 Firenze Italy.

Various biological and ethological features of Belonogaster griseus Fab. and related species (caste differentiation, division of work, nest cos=truction, dominance hierarchy etc.) are discussed in relation to the evolutionar trends amongs Polybiini or Vespidae.

16S-3,16 COMMUNICATION AND SWARMING AMONG NEOTROPICAL POLISTINAE. Jeanne, R.L. (Dept. Ent., Univ. of Wisconsin, Madison, WI 53706, USA)

The majority of species of Neotropical Polistinae initiate new colonies by means of swarms consisting of numerous workers and several queens. Experimental evidence for Polybia sericea indicates that the swarm is guided to the new nest site by means of a scent trail laid down by scouts, and that the source of the pheromone is a gland at the base of the fifth (penultimate) sternite of females. Histological and scanning electron microscopic studies of species in the genera Polybia, Apoica, Parachartergus, Synoeca, Pseudopolybia, Clypearia and Occipitalia show much variation both in the size of the gland and in the nature of cuticular modifications at the gland opening. There is evidence that some species use a different gland to produce a trail pheromone. Implications for the evolution of swarming behavior are discussed.

16S-3,17 INTERSPECIFIC DIFFERENCES IN DEFENSIVE TACTICS OF POLISTES WASPS (VESPIDAE).

Starr, C.K. University of Georgia, USA.

Social wasps of this genus have conspicuous behaviors which function as threats in the face of intrusion by vertebrates. Species differ in the array of threats which they commonly show under such provocation. In addition, they frequently differ in the characteristic sequence in which the same threats first appear under increasing provocation. The characteristic threat sequences are described for four nearctic species, and the influence of body coloration and some other factors in shaping the threat sequence is discussed. The threat sequence has some minor hierarchical elements in it, but it appears in general not to be a hierarchy of responses, but rather simply a set of responses released independently at varying levels of provocation. Male *Polistes* commonly threaten an intruder, and the prediction is tested that males will tend more to threaten in species with little sexual dichromism. Male *Polistes* are known to work, though infrquently, and the use of relative male threat tendencies offers a bright new opportunity for the study of male interests and male altruism, if it can be shown that this threat tendency is a good index of tendency to do other forms of work.

16S-3,18 BIOLOGY OF THE ORIENTAL PAPER WASP PARAPOLYBIA VARIA, WITH REFERENCE TO ITS POPULATION STRUCTURE AND LIFE STRATEGY.

Yamane, S. (Biol. Lab., Fac. Educ., Ibaraki Univ., Mito, 310 Japan)

More than 100 colonies of *Pp. varia* were observed in Taiwan between 1972 and 1975, with the following results: 1) Life cycle is annual, starting in December and persisting 10 - 13 months. Colony founding is polygynous in lowlands of southern areas, while monogynous in mountainous areas, suggesting that the degree of ant pressure is related with the mode of colony founding. 2) Absconding is very often observed after June and absconding colonies can also emit the sexuals, though the productivity is low. This may be highly effective in the colony survival when the colonies have long term cycle. 3) Usual colonies in lowlands construct 2000 - 3000 cells in ca. 10 combs, and produce 1200 workers, 300 males and 660 queens. Although the number of each caste or sex varies by colonies, the W / Q+M ratio is relatively stable (ca. 1.25) and the queen bias is the rule (Q / M = 2.2).

16S-3,19 Comparative biology of Vespa wasps in Japan.

Matsuura, M.(Lab. Ent. Mie Univ., Tsu, 514 Japan)

The hornet genus *Vespa* is advanced eusocial wasp with the other genera of the subfamily Vespinae. There exist at least seven species of *Vespa* in Japan. However, in these, the following five species, *V. mandarinia latilineata* Cameron, *V. analis insularis* Dalla Torre, *V. crabro flavofasciata* Cameron, *V. simillima* Smith and *V. tropica pulchra* Du Buysson are mainly concerned here. The life cycles of these five species are basically similar, but some variations in details of the life mode occure among them, and a comparison of their bionomics will be introduced, with special reference to nesting habit, food habit, annual cycle, ecological niche and population dynamics.

16S-3,20 TIME BUDGETS OF PAPER WASPS (*Polistes spp*.) AND TWO SPECIES OF MUD DAUBER WASP.

Hunt, J. H. (Dept. Bio., Univ. Missouri-St. Louis, St. Louis, MO 63121 U.S.A.)

Previous studies have shown that adult social vespid wasps can nourish themselves in two ways that solitary wasps cannot: via larval saliva received during trophallaxis, and via haemolymph extracted from larval provisions during malaxation. These nourishment sources may have been an important component of vespid social evolution in one or more of three ways: 1) by allowing greater foraging efficiency and, hence, a greater reproductive efficiency than in solitary wasps, 2) by facilitating reproductive longevity of a reproductive female leading to the potential for an overlap of generations, and 3) by contributing to "nutritional castration" of larvae that might then become workers. As a first test of this hypothesis, field behavioral studies of time budgets in several paper wasps (*Polistes spp*.) and two solitary sphecids (*Trypoxylon politum* and *Sceliphron caementarium*) are being carried out. Data from 1979 document the anticipated difference in time budgets between the social and solitary wasps. It is anticipated that data from 1980 will document basic similarities between time budgets of the solitary forms and single foundresses of the social forms before large larvae are present in the nest. The data collection system, which yields substantial amounts of quantitative data, will be described.

16S-4,21 Polygyny and Polydomy in Three North American Species of the Ant Genus *Leptothorax* Mayr (Hymenoptera: Formicidae)·

Alloway, T.M. (Erindale College, University of Toronto, Mississauga, Ont. Canada L5L 1C6), Buschinger, A., Talbot, M., & Stuart, R.

New colonies of *Leptothorax ambiguus* and *L. longispinosus* can be founded either by a single young queen or by a group of two or more such individuals; and mature colonies of these species and of *L. curvispinosus* can become polygynous or enhance the degree of their pre-existing polygyny by adopting young conspecific queens. Some colonies of *L. ambiguus* and *L. longispinosus* occupy more than one nest and maintain a continual interchange of workers, queens, and brood among the different nests (polydomy), while other mature colonies of the same species occupy only one nest (monodomy). The significance of these findings for understanding the evolutionary origins and maintenance of social parasitism is discussed, and speculations are offered regarding the adaptive value of these behavioural characteristics in the environment in which these species live.

16S-4,22 SOCIOBIOLOGICAL STUDIES ON THE POLYGYNIC ANT *LASIUS SAKAGAMII*.

Yamauchi, K. (Inst. Biol., Fac. Educ., Gifu Univ., Gifu, 502 Japan)

Lasius sakagamii has a peculiar polydomous system, characterized by 1) intranidal mating, 2) remaining of newly emerged queens in the mother nests, which results in a polygynic colony, 4) colony multiplication by budding, 5) enlargement of colony size up to several millions of workers. Further, the reproduction of this species is peculiar. In nests with very high queen densities (more than about 20 queens per nest area, m^2), or low worker/queen ratio (less than about 5,000 workers per queen) and high larva/worker ratio (more than about 5 larvae per worker), no queen is produced. On the other hand, the production of workers and males is larger in such nests than in those with low queen densities. *L. sakagamii* can saturate and dominate a preferred local habitat such as riversides and seashores by such polygynic and polydomous system.

16S-4,23 POLYGYNY AND POLYCALISM IN FORMICA LUGUBRIS ZETT. (HYMENOPTERA, FORMICIDAE).

Cherix,D. (Inst. of Zool and animal Ecol., Lausanne Univ., CH-1005 Lausanne)

The study of polygyny and polycalism in Formica lugubris Zett. related mainly to a super-colony situated in the Swiss Jura montain at 1400 m up. Concerning polygyny we stated that the majority of the nests are occupied by many queens; between 200 and 400 in secondary nests (middle size) and more than 800 queens in primary nests (big size). However we established that in some cases a high number (10-15%) are not fertilized. This fact results from unfertilized young females, which were carried back to the nests by the workers during the swarming period. Concerning polycalism, generally in our latitudes, many authors noted that the density of the nests of the red wood ant species (rufa group) increased with the altitude; our results show that this is on a par with the enlargment of polycalism. We can suppose that altitude is correlated with more rigourous climate and this allows some wood ant species as F.lugubris or F.aquilonia Yarrow to surpass other ant species (the diversity of which decreases with the altitude). The polycalism would offer "an economical solution" to gain over big territory considering the poorness of the altitude biotops. Nevetheless we observed a surprising modification of the diet: the ants eat a high percentage of Aphids (30%) with which they have trophobiotic relations. In this particular case, climate and restricted food resources lead the ants to a new ecological strategy which would express itself by the creation of super-colonies.

16S-4,24 STRUCTURE AND DEVELOPMENT OF A HUGE SUPERCOLONY OF FORMICA YESSENSIS FOREL.

Higashi, S. (The Inst. of Low Temp. Science, Hokkaido Univ., Sapporo, 060 Japan)

In a sandy shore Ishikari Coast (Hokkaido,Japan) a red wood ant Formica (F.) yessensis makes a huge supercolony, consisting of about 45,000 nests within ca. 2.7 km^2. Compared with European F. rufa group, each nest is moundless and very small, i.e. the nest diameter about 40 cm in average. In spring to early summer the inhabited nests increase by reusing nests abandoned in previous autumn or by newly building nests. In summer the nest abundance is nearly double of that in early spring. In autumn, however, many nests are abandoned, the abundance reaching the early-spring level before mid October. Such frequent budding and abandonment of nests are very rare in subgenus Formica. I will report some characteristics of this supercolony and, if possible, consider the process of development of such huge supercolonies in Formica.

16S-4,25 New results in regulating the structure of Formica polyctena societies.

Schmidt,G.H. (Dept. Ent. & Ecol., Univ. Hannover, FRG)

In Formica ants the determination of sexes takes place by a homo-hetero zygotic scheme but in both, males and females a further determinantal effect is necessary to get adults. Unfertilized eggs develop males, fertilized eggs produce females but both only after determination. This is favoured by a predisposition of the eggs: large eggs develop to females, small ones to workers, but if latter unfertilized the larvae die on the 2. instar. To get large eggs a vernalization of the queens is necessary. Furthermore, the nutrition is resposable for caste determination. In years with a long warm autumnal period the ants can store much of the food in the younger workers to produce a lot of sexuals in the coming spring. The young queens are adopted numerously and a division of the society generally takes place. The polycalic structure depends on the supply of food and the behaviour of the population.

16S-4,26 SOCIAL ORGANIZATION AND AGGRESSIVE COMPETITION IN ANTS.

De Vrooy, Cl. U.L.B. Brussels

Colony closure in ants is achieved by means of recognition odours, which are at least partly genetically degermined and hence queen dependent.

Some hypothesis have been made on the implicotion of yueens (number, relatedness, single or multiple insemination) in molding competition and aggressivc exclusion of aliens.

It is known indeed that intensity of aggression widely varies according to the species involved. However, the influence of social organization may be hidden by other factors playing an important part in the relationship between colonies: e.g. kind of resources and exploitation strategy, parabiose, phoromonal and allomonal prevention of interference.

It is the aim of this paper to review critically experimental data and field observations in the light of theäretical assumptions.

16S-4,27 Levels of organization in ant societies. Pisarski, B. Inst. of Zoology PAS. Warsaw, Poland.

In polycalic societies there is no intra-social competition, trophic area is common for all colonies composing polycalic colony, and workers can easy move from one ant-hill to another. They can also establish new colonies in areas rich in food. All those mechanisms let polycalic societies fit ant-hill spatial distribution and numbers of colonies to actual biotic conditions of environment. The high numbers of ant societies in connection with efficient system of information exchange and recruitment of workers, secure for them the prevalence other animals and it let them achieve very high status in domination hierarchy. So, they exert a strong biotic pressure upon environment and in some ecosystems they are one of the main components - ecosystem-creatig factors. Polyginism, polycalism, great numbers and plasticity secure for those societies the safety ant permanence. The impedency for them, to all intents and purposes, may be only the man or natural calamity. Amongst polycalic ant species we meet as well allies as enemies.

16R-1,2 Communication by tandem running during nest moving in Diacamma rugosum (Le Guillou) (Hym. Formicidae, Ponerinae). Abe,T. and Fukumoto,Y.(Dept.Biol.,Univ. Ryukyus, Naha.903 Japan)

Behaviour of workers in the procecess of nest moving of Diacamma rugosum was observed by using individual marking technique. This ponerine ant, which is large (8-10mm in length) and is widely distributed in South-East Asia (including Okinawa,Japan), but has not a queen in a colony, sometimes moves it nest. Nest emigration was induced in the laboratory by disturbing old nest, while at the same time providing a new nest nearby. Some workers (scouts) discovered a new nest and after inspection returned to the old nest. They began to recruit nest mates to the new nest site by tandem running. Some nest mates moved to the new sits by themselves. Males, larvae and eggs were transported by carring behaviour. A question " Do all workers of a colony have the same tandem-leader potential?" is interesting. So the division of labour of workers was also recorded in usual days(that is, not in the nest moving). The intensity of a worker as a tandem-leader in the nest moving was proportional to that of out-door activity in usual days.

16R-1,3

Previous observations on the ethology of the iberian formicid Cataglyphis iberica.Emery 1906 (Hym. Formicidae)

A.de Haro. Dept.Zool. Univ. Aut.Barcelona. Bellaterra (Spain)

Two nests are studied in Vallmoll (Tarragona), situated on the border of a vineyard, in argilous soil and at a distance each other of 40 m. Each colony has separated foraging activities but marking technique shows relations between the two nests; workers of each nest enter the other one. Also workers go out from one nest and carrying another worker or cocoon get into the other. The mean number of worker carriage from bigger nest to smaller one is 4 per hour between ten a.m. and three p.m. in august at 30°C. We presume by behavioral considerations that the carrying workers belong to the nest into which they enter with the carried ant.

Carriage is initiated facing the two ants with aggressive posture by the carrier and with submissive response by the carried. Thereafter they grasp themselves with their mandibles and the second is raised from the soil with ventral part of its body facing the carrier.

We are presumably in presence of unicolonial population (B.Hölldobler and F.O. Wilson, 1977.)

Daily activity in relation with temperature and humidity is also observed.

Orphan nest in laboratory, with 60 workers, after hibernation, lay eggs. Cocoon is induced by putting the workers earth on the larvae, and thereafter pupate.

Carriage from nest to arena has been observed grasping by the neck or petiole, with dorsal part of the body facing the carrier.

There are presumably two kinds of transport.

16R-1,4

RELATIVE WEIGHT OF THE GASTER OF COLONY FOUNDING ANT QUEENS.

TAKI, A. (Dept. Zool., Fac. Sci., Kyoto Univ., Kyoto,606 Japan)

Dry weight and fat content (reduction value from dry weight by ethyl ether extraction) of each part of body (head, thorax and gaster) of 40 species of ant queens were measured. Specimens used were restricted those collected just before, during or after the nuptial flight. Relative growth relations among these values show clear difference between the claustral type colony founding species and the other types (queen forages during colony founding, temporary social parasites, etc.) in relative weight and fat of the gaster. Thorax/head ratios vary 1.65-4.57 and show no remarkable difference. By gaster/thorax ratios these species are grouped into 2: those have smaller gaster, e.g. ratios are equal to or smaller than 1; those have larger ratios, 2-6 (claustral). Relatively lighter gasters have smaller amount of fat and it is considered that 40 % of fat is needed for claustral colony founding.

16R-2,5

THE EXTRANIDAL ACTIVITIES OF THE JAPANESE PAPER WASP, POLISTES CHINENSIS ANTENNALIS。

Kasuya,E。(Lab。Appl。Ent。Nema。,School of Agriculture,Nagoya Univ。,Nagoya 464,Japan)

Census of extranidal activities of Polistes chinensis antennalis was carried out by means of individual marking and tracking of individuals。 The extranidal activities were mainly composed of three parts i。e。 foraging, pulp-collection and water-collection in the founding and the ergonomic stages。 The home range and the foraging area were about 20m in radii in both stages and the areas in the founding stage were larger than those of the ergonomic stage。 No sign of the feeding territory was found。 Time needed for a single trip of foraging in the ergonomic stage was longer than that in the founding stage。 Time needed for a single foraging trip was longer than that for a single trip for pulp or water collection。 When a wasp caught a prey, she transported all flesh at once or by successive loading to her nest and searched the same place in the next trip after the exhaustion of the killed prey。

16R-2,6 SOME COLONY FACTORS AFFECTING THE HUNTING ACTIVITY OF *POLISTES CHINENSIS ANTENNALIS* (VESPIDAE, HYMENOPTERA).

Tetsuo, Hoshikawa (Fac. Agric., Kyushu Univ., Fukuoka 812, Japan)

In order to clarify the relationship between the hunting activity and the colony development in *Polistes chinensis antennalis*, some colony factors affecting the hunting activity were examined under field conditions in Fukuoka. The hunting activity increased with an increase in the number of 3rd to 5th instar larvae until the first male emerged. After the emergence of the first male the hunting activity decreased partly because the number of 3rd to 5th instar larvae decreased owing to cannibalism by adults and partly because workers devoted more labor to collecting liquid food than to hunting. It is concluded that the number of 3rd to 5th instar larvae has a great effect on the hunting activity of workers, but that the number of males has also an effect on it after the emergence of the first male.

16R-2,7 ARTIFICIALLY INDUCED MULTIFEMALE NESTS IN THE BASICALLY SOLITARY BEE *CERATINA JAPONICA*.

Sakagami, S.F. and Maeta, Y. (Inst. Low Temp. Sci., Hokkaido Univ., Sapporo, 060 Japan)

Ceratina japonica differs in some traits from other typical solitary bees, and occasionally two or more females occur in the same nest of brood rearing period. The artificial induction of multifemale nests was attempted by increasing the number of bees relative to that of available nest substrates. Using 173 females for 1976 - 1978, about 10 lasting two(or more) female nests and some temporary ones were obtained. Certain pre-caste phenomena were observed between the females staying in such nests. In all the cases, one female, usually larger one, behaved as guard without leaving the nest, while the other or others performed foraging and fed the guard. Egg laying was either restricted to the guard bee or not. The behavior types involved in this inter-female differentiation are mostly explained by the behavior in normal unifemale nests, particular by that in the mother-daughter co-existence period.

16R-3,8 The Role of Mandibular Glands in Caste Differentiation of Honey Bees (*Apis mellifera* Linn.).

Peng, Y. S. (Dept. Ent., Univ. of California, Davis, California 95616 U.S.A.)

A series of experiments were done to investigate the significance of the mandibular glands of workers bees in female caste differentiation. Groups of 30, 75, or 200, 10-day-old worker bees, with their mandibular glands removed surgically by means of specially designed apparatus, were caged in rearing cages in the laboratory. Each group was provided with female larvae in artificial plastic queen cups. Worker bees without their mandibular gland appeared to be able to feed larvae during the first 3 days after surgical operation. The larvae in the queen cups were fed by these treated worker bees throughout the entire larval feeding period, for the first 80 hours feeding period, or with larval food fortified with mandibular gland homogenate for the first 80 hours feeding period before being transferred to normal worker bees. Queen-like intermediates were reared in the experiments by treated worker bees, whereas normal queen bees were obtained by the control bees with mandibular glands. The results suggest that mandibular gland secretion is less important as a larval food in regard to supporting larval growth and caste differentiation, and the mandibular glands are probably not the only source of the "queen-determining substance."

16R-3,9 CHROMOSOME OF DIPLOID AND HAPLOID DRONES OF HONEYBEE, *APIS CERANA JAPONICA*.

Hoshiba, H. (Daito Bunka Univ. Daiichi High School, Itabashi, Tokyo, 175 Japan)

Naturally imbred queen of *Apis cerana japonica* produces the dioloid drone. They were reared up to the pupal stage in an incubator with the royal jelly of *A. mellifera* as a diet and in the same rearing of *A. mellifera*.

Chromosome preparations were made by the squash method(Imai and kubota, 1972), and the modified method from acetic acid dissociation drying technique(Crozier, 1968).

Chromosome number of *A. cerana japonica* was counted as 16 in haploid, and 32 in diploid drone. The chromosome count was done in the cells of spermatogenesis in each corresponding stage. The chormosome complement of haploid drone and diploid drone in this species showed the identical pattern as those of *A. mellifera*, i.e., eight metacentrics and eight submetacentrics in a haploid set. The longest metaphase chromosome was 4.1 um long, and the shortest one 1.5 um, after *in vitro* pretreatment with colchicine. The secondary constriction was clearly revealed in the longest chromosome. No homomorphic pair(Deodikar and Thakar, 1966) was observed in the haploid set.

The last named authors(1966) observed 16 chromosomes with 8 homomorphic pairs in a haploid set of *A. cerana*, and discussed from the evolutional point of view. The haploid drones of *A. cerana* and *A. mellifera* are originally diploid and the queen and worker tetraploid. From the results of the present study, the hypothesis of Deodikar and Thakar(1966) must be reconcidered.

Some homozygous alleles may make the diploids into the male. The sex determination mechanism in *A. cerana japonica* may be similar to that of *A. mellifera*. Further study on the sex determination mechanism from the cytologenetical point of view is in progress.

16P,1 PARENTAL CARE OF PENTATOMOIDAE (HETEROPTERA) IN JAPAN

Tachikawa, S. (Lab. of Entomology, Tokyo Univ. of Agriculture)

In a few cases of hemipterous bug one parent stands guard over the egg mass and youngs. This parental behaviour are known in the following species of Pentatomoidea in Japan.

CYDNIDAE : Sehirus niveimarginatus, S. triguttulus, Parastrachia japonensis
PENTATOMIDAE : Cantao ocellatus
ACANTHOSOMATIDAE : Sastragala esakii, S. scutellata, Elasmucha putoni, E. signoreti, E. dorsalis, E. fieberi, E. amurensis

The egg of Cydnid species are laid in the ground as boll-shaped mass. When disturbed, the female transfered the mass to another suitable place.

In the Pentatomid and Acanthosomatid species, the egg mass is deposited on the under surface of the leaf of each host plant. When gradually approached, the female displied behavioural pattern of the following four steps : 1) covering the egg mass by the body, 2) leaning her body to the approaching direction, 3) flapping of wings, 4) discharging of scent. This pattern is a form of parental protection toward eggs and 1st nymphal insters. When the guarding female of Sastragala esakii found the approaching of its egg-parasitic wasp, Telenomus sp., she quickly flapping the wings, and drives away the wasp. However, the parental protection is not complete, in the case of S. esakii the rate of parasite is more than 50% in each parasited egg mass. Other potential enemies, for example the ants atack the guarding female and ride her body or bite the legs, then were damaged by the discharged scent of the female. The females of Elasmucha spp. guard the nymphal group of 2nd and 3rd inster, too.

16P,2 ON THE SURVIVAL OF NESTS AND FORAGING BEHAVIOUR OF THE JAPANESE PAPER WASP, POLISTES JADWIGAE.

Hibino, Y. (Lab.Appl.Ent.& Nemat., Nagoya Univ., Chikusa, Nagoya, 464, Japan)

The survival of nests and foraging behaviour of the Japanese paper wasp, Polistes jadwigae, in the field from early May to later August, 1979. Study area(100x130m)was set up on the campus in Nagoya University. It was proved that the survival rate of nests during the reproductive period was 12% and the predation by Vespa was the major factor the mortality.

Mean foraging distance was estimated to be 40m. It was observed that both the foraging areas of some colonies and of workers of the same colony were overlapped. Nest reconstruction in the ergonomic stage and inter-colonial cannivalism among colonies of the same species shall also be reported.

16P,3 POLYCARIC DISTRIBUTION OF *FORMICA YESSENSIS* FOREL UNDER THE *QUERCUS-BETULA* FOREST AT MT. NORIKURA. Kondoh, Masaki (Shiraume Gakuen College, Kodaira, Tokyo 187 Japan)

The distribution of the ant mound and aggregating center of the red wood ant, *Formica yessensis* Forel was studied in the area of 0.4 ha. of *Quercus-Betula* community of the Norikura Height, 1450 m altitude, Nagano Prefecture.This height is fairly flat plain located at eastern slope of Mt. Norikura. All of the mounds and aggregating centers of this area were connected with each others by ant-trails, making a polycalic population. The aggregating centers were usually made at the side of rock, stamps or fallen wood materials and then grew up to the mounds. These were situated on the somewhat convex ground, where were well drainage. This distribution is also restricted to the area without a bricken *Pleridium aquillinum*Kuhn which grows along the thawing swamp.

16P,4 MORPHOLOGY AND FINE STRUCTURE OF THE SENSE ORGANS ON THE FLAGELLUM OF FORMICA RUFA L. (HYMENOPTERA; FORMICIDAE). Walther,J.R., (Inst.Allg.Zool., Free Univ., D-1000 Berlin, Fed.Rep. Germany

The morphology and fine structure of the sensilla on the flagella of the male, female and worker of F. rufa habe been investigated comparatively by SEM and TEM. There are no differences between the pattern of the sensilla of female and worker. Three olfactory sense organs (S. basiconica, S. trichoidea curvata, S. trichoidea), one gustatorical + mechanosensitive sensillum (S. chaetica), two mechanosensitive sensilla (tactile hair, S. campaniformia) and the S. ampullacea and S. coeloconica form the pattern of sensilla. The high number of sense cells innervating the olfactory sensilla of female and worker (S. basiconica 80-100; S. trich.curv. 40-50; S. trich. 11-16) is remarkable. The S. ampullacea are innervated by one sense cell, whose outer dendritic segment branches once at the base of the hair and a second time in the middle of the hair. The wall of the hair shows no pores. The S. coeloconica are innervated by four sense cells. The wall of the hair has pore channels. Both sensilla are morphologically clearly separate types of sensilla. There exists no intermediate type (cf.Jaisson, C.R.Acad.Sc.Paris 271,1191, 1970). The pattern of sensilla of the male shows some differences in comparison to the female and worker. There are no olfactory Sensilla basiconica. The innervation of the other olfactory sensilla is less extensive (S.trich.curv. 16-22, S. trich. 8-13 sense cells). Additionally, a sense organ with a short poreless peg, which is innervated by the three sense cells, one of which has a lamellated dendritic process,its found on the lateral part of the distal segment.

16P,5 Food preference, feeding behaviour and energetics of Odontotermes obesus and Odontotermes redemanni dominating in a tropical deciduous forest

SINGH, U.R., Deptt. of Zoology, V.S. Mehta College of Science, Bharwari, Allahabad, India

Communication embodies the following salient features;

1. Results of laboratory testings on food and feeding ecology of two termites species have been described.
2. Net annual input to decomposer cycle has been calculated.
3. Caloric values of food and individuals of test species have been determined.
4. Secondary productivity of test termites is given.
5. Energy turnover and its compartmental flow has been given in detail.

Section 17.

Sericulture.

17S-1,1 ANTHERAEA IN ASIA. Jolly, M. (Central Tasar Research Station, Ranchi, India)

Limited information is available on the variability in the Antheraea species in relation to its geographical distribution. The author has discussed the same, taking into account factors like follicular imprints on the egg shell, tubercular setae on the larval body, wing venation, chromosome number, etc.

17S-1,2 PRESENT STATUS OF MUGA SILK INDUSTRY, Choudhury, S. N.(North Eastern Council, Shillong, Meghalaya, India).

The culture of muga silk worm Antheraea assama WW: is practised as a subsidiary occupation in the Brahmaputra Valley of Assam. The main constraints in muga silk industry are scarcity of basic seed cocoon and the absence of a standard reeling device. Being an open country culture, it is beset with inherent limitations from the stage of plantation to fabric production. The cultural operation can be improved with the introduction of clonal plantation of Machilus odoratissima - the principal food plant, which ensures proper land use. The production of basic seed cocoon can be increased by preserving the best seed cocoons of spring and autumn broods at 5' C for about 100 days, so that the hazardous rearing seasons of summer and winter can be avoided. The newly devised power-driven reeling machine with automatic twisting arrangement can turn out uniform yarn in bulk quantity.

17S-1,3 THE INTRODUCTION OF ANTHERAEA YAMAMAI GUERIN (JAPANESE TUSSER) IN NAGANO PREFECTURE.Nakajima,F.(Sericultural Experiment Station Matsumoto Branch,Nagano-ken Agricultural Research Center,Japan)

It is thought that Japanese Silk Worms were first reared in the fields.The silk worm history of Nagano-ken is thought to have begun in the fields of Ariake,near the present town of Hotaka,in the Tenmei Era(1781-1788).The "Golden Age" of the silk worm industry was about 30 of the Meiji Era(1897).At that time the cocoon crop was estimated at about 8,500,000.But from 1897 to 1973 there had a variation in number.Since Showa 48(1973), we,the executive department and those concerned in this industry in Nagano-ken,have been trying to ask the farmers to rear the silk worms themselves and to expand the oak (Quercus Acutissima) fields.We are also expected to improve the technique of rearing them.

17S-1,4 ARTIFICIAL DRY FOOD FOR NON-MULBERRY SILKWORMS.

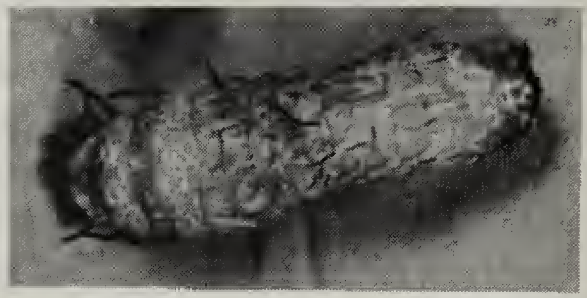
*Kikuchi,Y.,*Hotta,S. and**Higuchi,Y.
*(Kyodo Shiryo Co.Ltd.,Yokohama, 231 Japan) **(Sericultural Experiment Station,Tokyo, 166 Japan)

A new form of dry and foaming artificial food for non-mulberry silkworms has been developed by our original investigation. The dry food is convenient for transportation and storing, and very easy to feed the worms as it can be ready for use merely by soaking in water at any time. We conducted the rearing tests on the dry foods in various conbinations of ingredients such as oak leaf, soybean meal, glucose, cellulose, corn, wheat, gluten, etc. The performances of non-mulberry silkworms reared on the dry foods in several conbinations of ingredients were fairly good and those results seemed to be satisfactory for preliminary tests of artificial rearing. Since the food was also capable to keep itself humid and highly resistant to putrefaction during the rearing period, it seemed to be quite suitable for the practical and the industrial rearing of non-mulberry silkworms such as Japanese tusser (Antheraea Yamamai), Chinese tusser (Antheraea pernyi) and Eri Silkworm (Philosamia cynthia ricini).

17S-1,5 AN ECO-PHYSICAL STUDY ON THE EMPIRE SILKWORM, ATTACUS ATLAS L.

Lin, K. (China Culture College, Taipei, 113 China)

The empire silkworm, Attacus atlas L., could be reared in a ventilated dim room under 23-32°C, 75-95%RH through the whole larval stages (six instars, 50 days). The newly hatched larvae of A. atlas were fetched on the surface of the guava leaves, Psidium guajava, using a bottle cultivation, and the host-plant was changed once a week. It was proved that the cocoon sizes ranged between 6.5-8.0x2.4-3.5x2.0-2.8 (LxWxH, cm); the wing span ranged between 17-22cm which showed a lesser size than the wild type; the female moth laid 100-140 eggs on the fourth day after emergence, egg color changed steply from deep green via light green to light brown consequently coincided with the growth of eggs inside the body.



The 5th instar larvae (x2.2)

Cocoon of Attacus atlas (original size)

17S-1,6 EFFECTS OF ENVIRONMENTAL CONDITIONS ON THE GROWTH OF JAPANESE OAK SILKWORM (ANTHERAEAE YAMAMAI) IN INDOOR REARING.

Kuribayashi, S., M. Wakabayashi, Y. Kozakai and M. Kiuchi
(Chūbu Branch, Sericult. Exp. Sta., Matsumoto, 390 Japan)

Japanese oak silkworms are usually being reared in fields, where the silkworms are exposed to bad influences of nature such as damage from birds, insects, pathogens and weather conditions, etc., and therefere their cocoon crop is generally very low. If the indoor rearing of Japanese oak silkworms is made possible, the establishment of environmental conditions which are suitable for silkworm growth can be artificially made, and the stabilization of cocoon crop as well as the efficiency improvement of cocoon production will be expected. Tests were made to examine whether or not Japanese oak silkworms can be reared indoors as well as to clarify environmental conditions suitable for the indoor rearing. The result showed that Japanese oak silkworms grow considerably better indoors than outdoors by the following two methods:(a)Twigs of oak trees are cut and are inserted into water bottles. Silkworms are reared on those twigs. (b)Leaves are collected and fed to silkworms that grow in rearing box. The optimum temperature for rearing of larvae were about 29°C for the 1st instar, and loweres gradually with age, becoming about 25°C for the 5th instar. Daily 12 hours of light irradiation (another 12 hours put in dark condition) from larva newly hatched to moth emergence gave the best growth, and both the larval period and the pupal period were shortest. As to the influence of air current condition, the growth was best when an air current of 0.1-0.25m/sec. flew constantly in rearing room. The area of rearing bed required in case of box rearing was about 0.03m² per 100 larvae at the 1st instar and it increased up to about 0.7m² at the 5th instar. The amount of food ingested per larva under conditions suitable for growth was about 43g of oak leaves per fresh weight until larva became a mature one, taking about 74% of them at the 5th instar. The digestability was higher in younger larvae than in grown one, that was 40-35% in the 1st-3rd instar and 18-14% in the 4-5th instar. Incidentally, larva have a habit of drinking water (one larva drinks about 1.2ml at one time at the gluttonous stage of the 5th instar) and the cocoon quality is improved by water supply at the 5th instar.

17S-1,7 Record on the rearing of Antheraea proylei on Lagerstroemia flos reginae and studies on refrigeration of A. assamensis and A. proylei.

Bharali, N. (S.R.S. Dkhana)

Larvae of A. proylei experimentally reared of fourteen types of locally available plants preferred only the leaves of Lagerstroemia flos reginae. The broad leaved type of this plant is more preferable to the worms than that of small leaved ones. Worms found to have eaten the fresh green leaves leaving aside the old ones. A. proylei pupae responded well in long time refrigeration in comparison to A. assamensis.

17S-1,8 PHOTOPERIODIC AND TEMPERATURE CONDITIONS AFFECTING SUMMER DIAPAUSE OF ANTHERAEA YAMAMAI PUPAE. Kato, Y. and Sakate, S. (Dept. Biol., International Christian Univ., Tokyo, 181 Japan)

A. yamamai is a univoltine silkmoth endemic to Japan. However, a wide variation of diapause duration in the pupal stage under natural climatic conditions resulted in the limitted management of the species. In order to improve this problem, environmental factors affecting the pupal diapause were investigated. Exposure of the pupae to short-day or low temperature resulted in a quick termination of the diapause and a remarkable reduction of a variation range in the pupal duration. Furthermore, it was found that photoperiod during larval stage greatly influenced

17S-1,9 Some Behavioral Aspects of the Rearing of Some Species of the Non-mulberry Silkworm and Wild Silkworm. Okui, K. (Biol. Lab., Kitasato Univ., Sagamihara, 228)

It goes without saying that the rearing of the non-mulberry silkworm necessitates an intimate knowledge of its behavioral characters. Particularly, the selection of 'easy-to-handle' incects facilitates reading. For this reason, I have done comparative researches on the behavior of some species of the non-mulberry silkworm and wild silkworm and that of some hybrids between the silkworm and wild silkworm and have found that the aggregate nature among anything else is important for rearing. Thus, the rearing of those species makes it necessary to understand the behavioral chracters that each of them has and to conduct their rearing according to them. This time I have provided research data concerning, in particular, the first instar that plays an important role in starting feeding.

17S-1,10 CYTOLOGICAL AND GENETICAL STUDIES ON NON-MULBERRY SILKWORM IN INDIA.

Narasimhanna, M. and Rajashekara Setty, M. (Central Tasar Research Station, Ranchi 834005, India)

Cytological studies of Antheraea mylitta, A. assamensis and Philosamia ricini have been made. Recent studies on interspecific hybrids of Antheraea have shown very interesting features. While the hybrids of A. mylitta and A. frithii have revealed genetic incompatibility and sterility even with the same number of chromosomes, those of A. roylei and A. pernyi with great disparity in the chromosome number have exhibited synopsis in F_1 hybrids and also contributed for viable fertile offsprings. These recent observations are of much significance specially in bringing out the interrelationship between the different Antheraea species.
Studies on genetics of the wild silkworms was possible by systematic inbreeding and isolation of true breeding strains. Occurrence of natural mutants have also contributed in organising the genetic studies. While inheritance of the larval body colour in P. ricini is due to variation in a single gene that of A. mylitta is complicated and due to the interaction of many genes. Inheritance patterns of the interspecific hybrids are more interesting and have shown facinating results.

17S-1,11 GENOTYPE AND ENVIRONMENT INTERACTION IN MUGA SILKWORM ANTHERAEA ASSAMA WESTWOOD.

Subba Rao, G. (Central Silkworm Seed Station, Pampore, 192121, J & K, India)

The genotype and environment interaction was studied in two different larval varieties of muga silkworm Antheraea assama Westwood. It was observed that utilization of yellow and green variety muga silkworms in hybridization programme would be little helpful as the progeny of the cross may not be superior over its either parent in respect of various commercial characters.
The observation made from the interactions studied here that the summer rearings of muga silkworms are profitable, is at variance with the popularly known observation that rearing muga silkworm in spring and autumn seasons is more commercially viable than rearing it in summer.

17S-1,12 ON G-BANDING PATTERNS OF THE CHROMOSOME OF BOMBYX MORI AND SOME NON-MULBERRY SILKWORMS.

Tsutsui, I. (Yukigaya senior high school, Ohta-ku, Tokyo, 146 Japan) and Sakate, S.

In connection with the differentiation and specificity of non-mulberry silkworms, the mapping of G-banding patterns in Bombyx mori has been carried out in the pachytene bivalents. And three-dimention profies of G-banding have been shown by using photographic analizer. This method may be effective for identification, but some technical problems still remain in future. We are now trying to apply the same method to Antheraea yamamai, Dictyoploca japonica and Philosamia cynthia ricini.
From the cytological observation in the pachytene stage of primary oocyte, it may be decided that the type of sex determination in Dictyoploca japonica is XO type in female, that is, the chromosome number consist of thirty paired bivalents and one univalent. This seems to be a rare fact in Lepidoptera except Jalaeporia tubulosa reported by L. Seiler (1921).

17S-1,13 PHYSICO-CHEMICAL STUDIES ON *ANTHERAEA PERNYI* FIBROIN IN AQUEOUS SOLUTION

Kataoka,K (Sericultural Experiment Station, Ibaragi, 305, Japan), Kobayashi,Y., Fujiwara,T., and Kyogoku, Y. (Institute for Protein Reserch, Osaka University, Osaka, 565, Japan)

The aqueous fibroin solution which is homogeneous with respect to its molecular weight was obtained by direct extraction of fibroin from the posterior portion of the silk gland of *Antheraea pernyi*. The molecular weight of the fibroin was determined in a pH 10.3 carbonate buffer solution by sedimentation equilibrium to be 270,000. The circular dichroism spectra showed that the fibroin has an α-helical conformation at neutral pH in spite of the well known fact that the *Bombyx mori* fibroin has a random conformation in an aqueous solution. The α-helix to β-form transition was induced by pH change and also by temperature change. This transition was analysed by differencial scanning calorimetry and was found to be exothermic. The transition temperature was largely dependent on the fibroin concentration. At higher concentration up to 25 %, the α-helical conformation was stable. The critical concentration was 0.1 %. Nuclear magnetic resonance studies showed that a large change of the spin-lattice relaxation time for water protons occurred around this concentration and suggested that a "break of water structure" was accompanied by the transition. The differences in properties between the fibroins of *A. pernyi* and *B. mori* will be discussed.

17S-1,14 WEAVING AND DYEING OF THE COMPOSITE SILK FABRICS BY THE UTILIZATION OF NON-MULBERRY SILKS.

A. Aoki and H. Kato (Sericultural Experiment Station, Ibaraki, 305, Japan)

We have studied on the weaving and dyeing technique of the composite silk fabrics, the constituting of mulberry and wild silks to take advantage of the latter's characteristics for a development of newer silk fabric.

Although silks' favorite ground has hitherto been sheer stuff, we succeeded in weaving bulky and close fabrics by combining with tusser silks which have double the size of mulberry silk, and further effectively utilizing tusser silk's shrinking at steam-heat treatment like degumming which has hereto been a defect. Also, using plied yarns, we raised fabrics resistance to abrasion. Thick silk fabrics tend to produce the slipping of warp or filling threads. During sewing and after being made up, seams often slide. In suiting, is required a greater resistance to slipping. In view of the large frictional coefficient of tusser yarns, we combined them in warp and filling threads. And then we wove mixtures of mulberry and wild silks of least slippage and high in practical value. Trial manufacture of men's suits have been well accepted. The most suitable dyeing condition of tusser silk with reactive dyes was found out in consideration of uptake of dye and color fastness, and we could obtain brilliant shades and rich colors.

17S-1,15 Studies on flacherie of Chinese oak silkworm, *Antheraea pernyi*.

Yu, Chien-Ping.

17S-1,16 Yeh, Yuan-Po.

17R-1,1 DIAGNOSIS OF THE INFECTIOUS FLACHERIE IN THE SILKWORM, BOMBYX MORI, BY FLUORESCENT ANTIBODY TECHNIQUE, Ayuzawa, C. and Inoue, H. (Sericultural Experiment Station, Yatabe, Ibaraki 305, Japan)

Infectious flacherie in the silkworm, Bombyx mori was found in Japan (1960) and recongnized as one of the damageous disease in the sericulture in Japan. The symptom of this disease is non specific and diagnosis by naked eyes is so difficult. Use of the fluorescent antibody technique realized the precise and speedy diagnosis. In this method, specific fluorescence was observed only in the cytoplasm of the midgut cells. LD_{50}-time curve after per os virus inoculation showed a decreasing, an eclipse, an increasing and a stationary phase. Specific fluorescence in the midgut observed at about 20hr after virus inoculation. Furthermore knowledgment about the multiplication of the virus was abtained. Diagnosis by the fluorescent antibody technique is abailable for the estimation of the occurrence of the disease by observation of diseased larvae in the younger stage, and is used now in sericultural field in Japan.

17R-1,2 LINKAGE ANALYSES OF THE FIBROIN MUTATIONS IN THE SILKWORM (*BOMBYX MORI*). Doira, H., Nakayama, M., Machida, Y. and Watanabe, T. (Inst. Silkworm Genet., Kyushu Univ., Fukuoka, 812 Japan)

Fibroin is exclusively synthesized in the posterior part of the silk gland. Silkworm larvae homozygous or heterozygous for *Nd* mutation spins a very thin cocoon consisting only of sericin. Sprague and Roth (1979) have shown allelic variants with altered coding lengths of a single fibroin gene which produce different length fibroin protein. The allele producing longer fibroin is Fib^L; that producing shorter fibroin, Fib^S; Fib^M produces middle sized fibroin; here referred to as *L*, *S* and *M*, respectively. To examine genic relation of *Fib* and *Nd*, backcrosses of the type 1.(*Nd* x*L*) x *L* and 2.(*Nd* x *S*) x *S* were carried out. Since *Nd* larvae never secrete fibroin, fibroin solutions in 8M urea were prepared from posterior silk gland of Nd^+ progenies. Electrophoresis on 4-15 % gradient SDS-polyacrylamide gels gave single band pattern, fibroin appearing in the cross-1 was indistinguishable from the long parental fibroin, that appearing in the cross-2 was of parental short. This result suggests that *Fib* is linked with *Nd*. In the linkage experiment on a newly discovered tubby mutation (*tub*), female test-cross *Nd/tub* x *tub* gave progenies only of parental genetic constitutions. This indicates that they are linked with each other, constituting a new, the 23rd, linkage group among 28 haploid chromosomes. COV was calculated as 19.8 % from 2078 *Nd +* : 521 *++* : 403 *Nd tub* : 1666 *+ tub* segregation of the reciprocal cross. To test further whether fibroin size alleles were linked with *Nd*, we performed backcrosses between *tub M/+ S* F_1 heterozygotes and *tub L/tub L*. Female test-cross showed that *Fib* gene was linked with *tub*, fibroin of *+/tub* was *S/L* while that of *tub/tub* was *M/L*. Fibroin patterns of *+/tub* progeny in the backcross of F_1 male, showed 77 *L/S* : 51 *L/M* segregation, giving 39.8 % COV. These results provide strong evidence that the fibroin structural gene *Fib* and the *Nd* gene, defect of fibroin synthesis, are located somewhat apart on the same chromosome.

17R-1,3 AMYLASES OF DIGESTIVE JUICE FROM BOMBYX MORI AND SOME LEPIDOPTERA: ISOZYME CONSTITUENTS AND IMMUNOLOGICAL IDENTITY.

Hara, W., Koga, K. and Sakaguchi, B. (Fac. Agric., Kyushu Univ., Fukuoka, 812 Japan)

The ae locus is related to the activity of digestive juice (DJ) amylase in B. mori (Matsumura, 1933). We found that DJ obtained from $+^{ae}$ larvae such as p50 contains amylase which migrates toward the negative (cathode) pole during slab gel electrophoresis at pH 7.5. The starch-iodine reaction made on the gel at pH 9.4 revealed that the cathode amylase was separated into 4 or 5 active components; the alternative number depended upon the strain. No such cathode amylase was detected in DJ from ae strains. We referred to these respective amylases as 4-band-type or 5-band-type cathode isozymes, in order to distinguish them from anode-migrating amylases which are low in activity but detected generally in DJ of B. mori. Rabbit antiserum against the highly purified 4-band-type cathode isozymes from p50 was found to absorb completely the activities of the 4- and 5-type isozymes from $+^{ae}$ silkworms tested, but not the activities of the anode amylases. These cathode isozymes formed a single band of precipitation under the Ouchterlony test. DJ's were collected from lepidopterous larvae such as Bombyx mandarina, Philosamia cynthia pryeri, Antheraea yamamai, Lymantria dispar japonica etc and were electrophoresed under the above conditions. These samples exhibited several amylase isozyme bands and fell into 3 groups according to the mode of migration: (1) Cathode type, (2) anode type and (3) cathode-and-anode type. Despite the electrophoretic diversity, these lepidopterous amylase isozymes showed clear-cut absorption by the antiserum against the silkworm cathode isozymes. This is in contrast to the case of Drosophila melanogaster and D. hydei amylases which did not show immunological cross reactions (Abraham and Doane, 1974).

17R-1,4 GENETICAL STUDIES ON THE ABSENCE OF SPHERULE CELLS IN THE SILKWORM (*BOMBYX MORI*).

Ninaki, O. and Doira, H. (Inst. Silkworm Genet., Kyushu Univ., Fukuoka, 812 Japan)

The blood cells of the silkworm are classified into five types: proleucocytes, plasmatocytes, granular cells, spherule cells, and oenocytoids. Among 301 silkworm races examined, 31 strains lacked spherule cells in the hemolymph of larvae tested, whereas spherule cells normally make up about 10 % of the hemocyte population at the early stages of each larval instar. Absence of spherule cells may be inherited as single dominant or as single recessive, depending on the spherule-cell minus strain used in mating experiments. Linkage analysis revealed that the dominant spherule-cell minus (*Sph*) gene was linked with the red hemolymph (*rb*) which had been known to be located on the 21st chromosome: Female test-cross of the type *+ Sph/rb +* x *rb +* gave progenies only of parental genetic constitutions, 107 *+ Sph* and 108 *rb +*. The locus of *Sph*was determined to be 9.1 of the 21st linkage group by a three-point experiment involving *rb*, *Sl-v* and *Sph*. Silkworm larvae of *Sph* genotype have a shortened larval life and produce less silk, body weight of *Sph* pupae is lighter than normal. Parabiosis and injection experiments between *Sph* and normal animals have shown that the *Sph* hemolymph have no influence on the spherule cells, pre-existing and differentiating, of normal animals. The recessive spherule-cell minus (*spr*) gene, on the other hand, was independent of *rb* but was linked with w^{ol} belonging to the 10th linkage group. Recombination value between w^{ol} (locus 19.6) and *spr* was 6.2 %. Taking correction factor, obtained through a three-point experiment additionally involving *w-1*, into account, the *spr*locus was determined to be 12.1 position.

17R-2,5 PERSENT STATUS OF ERI SILK INDUSTRY

Chowdhury, S. N., (North Eastern Council, Shillong, Meghalaya, India).

The culture of eri silkworm Philosamia ricini Linn: practised as a subsidiary occupation for production of eri silk by the tribals of North Eastern India can be made economically more viable through rearing the worms in early stages on tender leaves of tapioca (Manihot utilissima) followed on the last stage by mature leaves of castor (Ricinus communis) of high tuber and seed yielding varieties respectively. Resulting silk being spun, its value is less; however byproducts like tuber, seed, crisalids etc. can contribute towards additional earning. The 'Ambar' spinning device is an important innovation for spinning in cottage level, where yarn output is high and production cost is minimised. This well-replaces the traditional 'Drop Spindle' having a low outturn. Eri yarn blended with Ramie (Baumeria nivea or tenassissima) yarn can lead to the production of fabrics, which will be cheap and will in addition, have other desirable characteristics.

17R-2,6 EXPERIMENTAL LIFE TABLE OF ERISILK MOTH, PHILOSAMIA RICINI HUTT. (LEPIDOPTERA: SATURNIIDAE) ON CASTOR AND TAPIOCA LEAVES.

Misra, S.D. and Joshi, K.L. (Dept. Zool., Jodhpur Univ. Jodhpur, 342001 India)

Life table of the castor silkworm, Philosamia ricini was built from laboratory rearings under four alternatives, A to D, using two host plants, the castor and the tapioca. A: complete larval period on castor leaves; B: complete larval period on tapioca; C: First to third larval period on tapioca and rest on castor; D: First to third larval period on castor and rest on tapioca. Life expectancy (ex) was highest in condition B and lowest in condition A, while in condition C, it was higher than in D. The Net reproduction rate (R_o), the Innate capacity of increase (r_m) and the annual biotic potential (BP) were all maximum in condition A and minimum in condition B, while in condition C these were higher than in D. From all these it appears that castor leaves are the best for all the parameters.

17R-2,7 THE OVICIDAL ACTION OF ORGANOPHOSPHORUS INSECTICIDES ADMINISTERED DURING THE LARVAL STAGE IN SILKWORM (BOMBYX MORI).

Kuribayashi, S. (Chūbu Branch, Sericult. Exp. Sta., Matsumoto, Nagano, 390 Japan)

When silkworm larva are poisoned by organophosphorus insecticides such as parathion, EPN, fenthion, disulfoton, etc., specific ovicidal action on eggs laid (death occurs just before hatching or just after hatching) is induced. The way in which ovicidal action occur differ with the type and dose of the chemicals used, sex of silkworm, age at which poisoned, and period of administration, but these ovicidal action only result from poisoning of the female, and occur most often when poisoned from the last half of the fifth instar to first half of the pupal stage (before the egg shell is formed in the body). The respiration and the cholinesterase activity of the embryo of abnormal eggs during the early to middle stage was almost the same as for normal eggs, but at the terminal stage, particularly at about 2 days before the scheduled day of hatching, abnormalities occurred rapidly. The amount of chemicals transferred from the mother's body to the eggs laid in case of parathion was about 2.7 ng per one egg (4.8 ppm per weight of eggs), and this was the same as the lethal dose for hatched larva. From these results, the cause of the ovicidal action of organophosphorus insecticides administered during the larval stage is assumed to be as follows: A part of the chemical entered the silkworm body during the larval stage, remained in the body without being neutralized or excreted even after pupation, transferred in to the egg during the process of egg formation, remained there even after the eggs were laid, and then inhibited cholinesterase activity in the embryo which was rapidly activated during the period just before hatching. It requires special attention that such peculiar residual toxicity is observed with organophosphorus chemicals which are considered to be easily broken down in the living body at a dose low enough not to cause the mother to die.

17P,1 ROLE OF INDUCED MUTATION IN SILKWORM BREEDING

Datta, R.K., Samaddar, S. and Das, S.K.

The indigemous silkworm race "Nistari" of Bombyx mori is a poor silk yielder but a very hardy race that can withstand the vagaries of tropical climates. Since its response to selection was found poor due to continuous inbreeding, mutation breeding experiments were undertaken to induce new genetic variability which may respond to directional selection for eliminating the disadvantageous traits and subsequent fixation of high yielding chracters. Results indicated that both physical, x-rays and y-rays and chemical mutagens like EMS were useful for isolation of beneficial mutations when low dose of mutagens was used during less sensitive stadia of gametogenesis. In the new breeds which were evolved through clonal selection from mutant lines as also by cross breeding of various promising lines, estimated silk yield has extended upto 90% over that of the indigenous race. The comparative analysis of the silk yield in breeds evolved through mutation breeding and hybridization of exotic and indigenous race showed that the absolute silk content is higher in the former due to less mortality during rearing.

17P,2 INTERSPECIFIC HYBRIDIZATION OF ANTHERAEA ASSAMENSIS WESTWOOD AND ANTHERAEA PROYLEI JOLLY.

Bharali, N. (Sericultural Research Station, Dhakuakhana, Assam, India)

A possibility of evolving a new strain of muga (Antheraea assamensis Ww) by crossing the females of A. assamensis Ww with the male of A. proylei J or its reciprocal was found, though their chromosome number differ from each other. A difficulty arose for easy pairing between these two species, perhaps, because of their different geo-climatic conditions. A problem for food plant was faced for rearing the progeny of the interspecific hybridization.

17P,3 EFFECT OF SORBITOL ON THE TERMINATION OF DIAPAUSE OF SILKWORM EGGS UNDER CULTURE CONDITIONS.

Ohtsuki,Y.,Kitazawa,T. and Kanda,T.(Sericult. Exp. Sta., Tsukuba, Ibaraki,305,Japan)

When 5 to 180-day- old(at 25 C) diapausing silkworm eggs were deprived of their chorion and cultured in hanging drops of Grace's insect tissue culture medium, 0.27 M saccharose or 0.27 M raffinose, the termination of their diapause completed within 36 to 48 hr and embryonic development started. Whereas the development of embryos in the diapausing egg cultured in the same manner in the drops of 0.54 M sorbitol varied with the age of eggs, that is, more than 78 % of living embryos developed when cultured at the age of 5 to 32 days(at 25 C), but the percentage of developed embryos decreased with age after that, and the percentage of living undeveloped ones increased, reaching 90 to 98 % in the eggs cultured at the age of 103 to 150 days (at 25 C). These results suggest that sorbitol takes part in the prolongation of termination of embryonic diapause under the conditions of culture.

17P,4 BYPATH OF PHENYLALANINE AND TYROSINE OBSERVED IN THE INTOXICATED BOMBYX LARVA WITH MTMC (m-TOLYL-N-METHYLCARBAMATE).

Sugiyama, H. (Sericul. Expl. Stat. Ibaraki, 305 Japan)

Labelled phenylalanine or tyrosine administered to the fifth instar larvae was metabolized in a routine way, that is, from phenylalanine to tyrosine, DOPA and DOPAMIN. Whereas, MTMC administration altered thus aromatic amino acids metabolism. Since an interconversion between phenylalanine and tyrosine was blocked by MTMC, most of phenylalanine converted to PLA (phenyllactic acid) and HPLA (p-hydroxphenyllactic acid). MTMC did not markedly altered the coversion from tyrosine to DOPAMIN, but some radioactivity was recovered in HPLA, coming from labelled tyrosine in only the case.

17P,5

REELING OF EMERGED TASAR COCOONS. Majhi, S., Ghosh, S., Sengupta, D. and Narasimhanna, M. (Central Tasar Research Station, Ranchi 834005, India)

The emerged tasar cocoons were hitherto considered to be unfit for quality raw silk extraction, because of the concept that the moth while emerging out of the cocoon pierces through it cutting the filaments, thus bringing in discontinuity of the fibre. The emerged cocoons from grainage was considered as bye-product and used only for preparation of coarse spun-yarn.
Observations made on the emerged cocoons of Antheraea mylitta and A. proylei have shown that due to the action of proteolytic enzyme by the moth the peduncle end is softened and silk is dispursed without breaking the continuity of the fibre.
The study has also revealed that by use of proper softening agents and after softening the sericin, the filament from the cocoon can be reeled to unwind the filament. It is also observed that the production of reeled silk is more economical than the hand spun silk in emerged cocoons both in A. mylitta and A. proylei. While there is no significant difference in the silk production between emerged and normal cocoon in A. proylei, the same is 60% as compared to normal cocoon in A. mylitta.

17W-1,1

COMPARATIVE STUDIES WITH THE SILKWORM LARVAE REARED ON MULBERRY LEAVES AND ARTIFICIAL DIETS. Hayashiya, K. (Lab. Biochem. Kyoto Technical Univ., Matsugasaki Kyoto, 606 Japan)

Researches on raising the larvae of Bombyx mori on artificial diet have been undertaken both scientific purposes and for practical use in Japan. The artificially raised worms produced almost same kind of cocoons as those raised on natural diet, mulberry leaves. But recent researches (Hayashiya, 1978 and Shimizu, 1976,1978) revealed that some physiological differences existed between the two.

Lack of anti-viral activity, reduced production of pheromone, Bombykol, and loss of phototactic behaviour in the insects reared on artificial diets will be pointed out in this paper.

17W-1,2

ARTIFICIAL DRY FOOD FOR SILKWORMS. Hotta, S. and Kikuchi, Y. (Kyodo Shiryo Co.,Ltd., Yokohama, 231 Japan)

A unique form of the dry artificial food, processed by freeze-drying the pre-cooked moist mixture, has been developed for the silkworms by our original investigation. Since the dry food can readily be used merely by soaking in water at any time when necessary, the rearing of larvae of the silkworm is able to be done very conveniently in any place. The dry food is also suitable for testing the effect of the additive, dietary substances on the silkworm, because the testing substances can be immediately and evenly distributed in the food by dissolving in the soaking water.
In this report we will present several characteristics of the artificial dry food.

1. Method of the formulation, processing and handling of the diet and rearing results on the food.
2. Application of the dry food to the feeding tests of the additive, dietary substances.
    (1) Feeding tests of several anti-fungal reagents for preventing fungal growth on the surface of the food during the rearing peiod of the 1st - 3rd instars.
    (2) Effects of addition of glycine and/or L-alanine at varying levels on the cocoon qualities, when fed to the 5th-instar larvae.

17W-1,3 A PURE SYNTHETIC DIET FOR THE GROWTH OF THE SILKWORM, BOMBYX

Mori, L. Lin, K. (Dept. Zool., Kyoto Univ., Kyoto, 606 Japan)

A pure synthetic diet containing basal components, w-components, e-components, compensational factors, and molting factors, elicited a normal growth in the domestic silkworm through the whole larval stage.

17W-1,4 DIETARY REQUIREMENTS OF THE SILKWORM, BOMBYX MORI, AND ITS ARTIFICIAL DIETS.

Ito, T. (Sericul. Exp. Stn., Tsukuba, Ibaraki-Pref., 305 Japan)

The entire rearing of the silkworm, Bombyx mori, on an artificial diet has first been reported in 1960. Extensive studies have been made on the improvement of the diet both on the fundamental and on the practical points of view during the last two decades. At present, the authorized artificial diets for the practical use are available commercially in Japan.

Artificial diets for the silkworm have to meet at least four main requirements, similar to those reported for other species of insects; the diets are needed principally to satisfy the qualitative and quantitative nutritional requirements, to possess the suitable physical properties, to be free from the microbial contamination as possible, and not to contain possible deterrent or repellent.

A few years ago the Ministry of Agriculture, Forestry and Fisheries of Japan has started to put the artificial diets to practical use for rearing of the younger larvae (for the period of the 1st to the 3rd instars exclusively) in the cooperative rearing houses in the farm area. In 1979 the younger larvae from about 120,000 boxes (one box, approximately 20,000 eggs) have been reared on artificial diets (thereafter on mulberry leaves) with a successful result.

Section 18.

Acarology.

18S-1,1 ASPECTS OF THE REPRODUCTIVE BIOLOGY OF ERIOPHYOID MITES, WITH SPECIAL REFERENCE TO ACULUS CORNUTUS (BANKS).

Oldfield, G. (Boyden Entomology Laboratory, Federal Research, SEA, USDA, Riverside, California 92521 USA)

In the Eriophyoidea the insemination process involves visitation by females of stalked spermatophores deposited on the host plant. In the case of Aculus cornutus (Banks), the rate of spermatophore deposition is several times greater than the rate of oviposition. Protogynes of A. cornutus inseminated from one spermatophore containing circa 50 spheroid sperm cells store sperm in one of the pair of spermathecae and produce predominantly females for several days. Then, as the supply of sperm is exhausted, only males are produced even when given further access to spermatophores. The number of females produced indicates a ratio of circa one fertilization per two available sperm cells. Deutogynes of A. cornutus, inseminated from single spermatophores overwinter in a torpid state without males. The following spring they produce males and females in numbers similar to those produced by protogynes. Observations of 20 species of Eriophyoidea indicated sperm storage in only one spermatheca is common among Eriophyidae. Two observed Rhyncaphytoptidae stored sperm similarly but both species of the relativity primitive Nalepellidae stored sperm in both spermathecae. Studies of the response of uninseminated females of Aculus cornutus to spermatophores of other species of Aculus, and of other genera, suggested some interspecific but no intergeneric recognition of spermatophores. Females of A. cornutus visited and became inseminated from spermatophores depositied by Aculus schlectendali (Nalepa) but the absence of subsequent production of females indicated that fertilization apparently failed to occur.

18S-1,2 ACARINA OF THE GENUS TETRANYCHUS INJURIOUS TO ECONOMIC PLANTS IN THE TROPICAL INDO-PACIFIC AREA.

Gutierrez, J. (Centre O.R.S.T.O.M., B.P. A5, Noumea, New-Caledonia)

The Acarina belonging to the genus Tetranychus in the tropical Indo-Pacific area are listed from mites previously recorded and from material collected by the author. Although the information is fragmentary, the distribution of those spider mites depends on their intrinsic potentialities and reflects the influence of man in the introduction and the establishment of the species of economic importance.

18S-1,3 BIOLOGY AND ECOLOGY OF PHYTOSEIID MITES ON SUBTROPICAL FRUIT TREES OF ISRAIL.

Swirski, E. (Div. Ent., Agric. Res. Org., Bet Dagan, Israel)

The paper deals with 13 species of phytoseiid mites collected on citrus, and 4 species recorded from avocado. Data are given on the phenology, biology and nutritional requirements of the following common species: Typhlodromus athiasae Porath and Swirski, Amblyseius swirskii Athias-Henriot, Iphiseius degenerans (Berlese) and Euseius rubini (Swirski and Amitai). All postembryonic stages of these mites are active throughout the winter. A graph of the amounts of selective and non-selective pesticides used in Israel on citrus since the 1950's is presented. The effects of these pesticides on phytoseiid and phytophagous mites are discussed. In avocado plantations biological control methods have created a favorable environment to phytoseiids.

18S-1,4 LIFE-TYPE AND LIFE-HISTORY CHARACTERISTICS IN TETRANYCHIDAE.

Saitô, Y. (Institute of Applied Zoology, Hokkaido Univ., Sapporo, 060 Japan)

Through experimental studies on the spinning behavior of the spider mites, a schema showing the relation of this behavior to the process of construction, final structure, and function of the webs has been made. Gazing at this schema the life habits of 30 species belonging to 7 genera of Tetranychidae in Japan have been grouped into three major life types, i.e. irregularly stratified (SW), weaved nest (WN), and webless (WL). When experimented under fairly uniform environmental conditions (25±1°C, 50-70% RH, and 15L9D), the species of SW type gave comparatively high values of r_m (intrinsic rate of natural increase) owing to their rapid developments and high reproductive rates, while those of WN type gave a very low r_m values due to their delayed developments and low reproductive rates. The species of WL type gave intermediate r_m values between the above two. The spider mites of SW type with high r_m are generally polyphagous and have unstable habitats (host plants), but those of WN type with low r_m are monophagous, having basically stable habitats.

The life types are thought, therefore, to be intimately correlated with the life-history strategies and host-plant stabilities of particular species and to explain how these have successfully adapted themselves to their respective environments.

18S-1,5 EFFECTS OF SEASON ON THE PREDATION AND DISPERSAL OF PHYTOSEIULUS PERSIMILIS ATHIAS-HENRIOT TO THE KANZAWA SPIDER MITE ON STRAWBERRIES IN PLASTICS GREENHOUSES.

Shinkaji, N., Hamamura, T. and Ashihara, W. (Faculty of Horticulture, Chiba Univ., Matsudo, 271 Japan)

The predator efficiency was estimated through a comparative study on the population changes of *Phytoseiulus persimilis* Athias-Henriot and *Tetranychus kanzawai* Kishida, as well as the speed of dispersal of the phytoseiid mite on strawberries in plastics greenhouses following the introduction of phytoseiid mites into the prey population on the plants during late March through late April. Later the season the predators were released, the period from predator inoculation to prey suppression was shorter. It was inferred that number of prey mites consumed by predator per day increased and the dispersal inter plants of the predator became faster because of higher temperature in later season.

18R-1,1 THE SIMULATION MODEL OF CITRUS RED MITE, PANONYCHUS CITRI, McGREGOR ON CITRUS.

Furuhashi, K. Nishino, M. [1]Shiomi, M. and [2]Muramatsu, Y. (Lab. of Plant protection, Shizuoka Citrus Exp. Sta. 2712 Komagoe Shimizu-shi Shizuoka-ken, Japan)

The citrus red mite, *Panonychus citri*, McGregor is the most destructive mite pest for citrus trees in Japan and frequently requires control with mitcides in a year.

The population model is very important to estimate the density and the threshold of mites for control.

We discuss feature of developing, oviposion, mortality, dispersal, natural enemy and influence of climate on citrus red mite in this model, and results of simulation too.

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[2] Shizuoka Agricultural Exp. Sta., Shizuoka-shi Shizuoka-ken, Japan.

18R-1,2

NUMERICAL OSCILLATIONS IN AN ACARINE PREDATOR-PREY SYSTEM ON APPLE. Van De Klashorst, G. (Zoology Dept, Australian Nat. Univ., P.O. Box 4, Canberra A.C.T., Australia 2600)

A system comprising *Typhlodromus occidentalis* (Nesbitt) and *Tetranychus urticae* (Koch) was studied in a glasshouse at 25°C on 6 blocks, each of 48 apple seedlings maintained continuously in leaf. In three blocks the seedlings were linked up by a grid of dowelling sticks. All blocks were routinely sprayed with azinphosmethyl, captan and bupyrimate according to commercial procedure. Initial densities were 0.10 prey and 0.04 predator per leaf. During a 40-week period, 3 oscillations occurred at intervals of ca. 12 weeks. In the 'connected' blocks, mean peak densities were 318.18, 4.08, and 164.46 preys, and 1.31, 1.20, and 7.20 predators, respectively, per leaf. In the 'unconnected' blocks, mean peak densities were 472.81, 23.73, and 258.44 preys, and 1.88, 1.08, and 4.85 predators, respectively, per leaf. Higher prey densities in 'unconnected' blocks were attributed to lesser predator mobility in them. Applications of pirimicarb for aphid control reduced predator numbers at the time of the first and third peaks, which allowed prey to achieve damaging densities. The second peak was considered representative of predator-prey interaction when the development of the predator was not impeded. No predator eggs were found when prey numbers were minimal.

18R-1,3

EFFECTS OF THE WATER SPRAYING ON THE POPULATION DENSITY OF THE CITRUS RED MITE, PANONYCHUS CITRI, IN CITRUS ORCHARDS. OKAMOTO, H. (Lab. Appl. Ent., Fac., Agr., Kagawa Univ., Miki-cho, Kita-gun, Kagawa-ken., 761-07 Japan)

The controlled water spraying (2-3 times per day, 10-15 minutes per time, 1-1.5 mm³ per cm² per time) by irrigation sprinkler was carried continuously for 10 to 15 days in the orchard of Satsuma mandarine orange and the change of population density of the citrus red mite on orange gloves was examined.

The density of mite population on the gloves in the plot of water spraying decreased rapidly and was maintained under tolerable pest density.

From the results of examination the water spraying by irrigation sprinkler seemed to have an utility value as a new method which enable to improve a heavy use of acaricides in the mite control.

18R-1,4

Resistance development in Tetranichid mites on vegetable fruit crops to acaricides
Kobayashi, Y., Fukazawa, N. and Ikeda, F. (Shizuoka agr.expt.sta., Shizuoka, 420 Japan)

Several species of Tetranichid mites such as *T.urticae*, *T.kanzawai*, *T.cinnabarinus* and *T.desertorum* were observed in vegetable fruit crops grown in fields and greenhouses in shizuoka prefec ture. The susceptibilities of several mite populations taken from vegetable fruit crops to dicofol and dichlorvos were tested. Populations of *T.urticae* showed low susceptibility to both chemicals. The mortality of female *T.urticae* showed low susceptibility to most of the practical concentrations of seventeen chemicals except prothiophos, polynactins and cyhexatin. On the contrary, the ones of *T.kanzawai* and *T.cinnabarinus* showed higher susceptibilities to the tested chemicals. Among them, proclonol, phenisobromolate, BCPE in adition to above-mentioned three chemicals were effective. Since the variations in the susceptibility to these chemicals were observed among the tested populations of *T.urticae*, the resistance of this mite to these chemicals may be developed in the fiels.

Control of these mites with a predcious mite *Phytoseiulus persimilis* on strowberry plants in vinylhouses was effective especially in March when the prey mites start to increase. The effects of physical means for preventing crops from the contact of mites are under investigation.

18R-2,5

STUDIES ON THE CAUSE OF THE MITE INDUCED(?) STERILITY OF RICE IN TAIWAN.

Lo, K.C., Liu, D.J. and Chien, C.C. (Taiwan Agric. Res. Inst., Taiwan, China)

A series of experiments were conducted to clarify the cause of the mite induced sterility of rice plants. Four treatments, i.e. rice plants subjected to (1) rice tarsonemid mite, *Steneotarsonemus spinki* only (M), (2) rice tarsonemid mite plus sheath rot fungus, *Sarocladium oryzae* (M+F), (3) sheath rot fungus only (F) and (4) check (CK), were compared of their influences on several agronomic characters of Tainan No. 5 rice; their nitrogen and total non-structural carbohydrates concentrations were also determined for showing the mechanism of sterility.

Rice plants infested with tarsonemid mite only showed a significant increase in sterility rate and decreases in panicle weight, average weight of grains, tiller number, length of panicle neck and plant height when compared with Ck treatment. Similar results were also found in treatment of M+F. The infestation of rice by sheath rot fungus only caused decreases in average weight of grains and plant height. However, other characters, sterility rate in particular were not affected by this disease.

In mature stage of rice, percent nitrogen concentrations in dried straws(culm+leaf sheath) of M, M+F, F and CK were 0.79, 0.67, 0.61 and 0.59, respectively; and those in panicles were 1.52, 1.34, 1.07 and 1.03, respectively. Percent concentrations of total non-structural carbohydrates in dried straws were 35.4, 31.4, 16.8 and 17.22, respectively; and those in panicles were 37.4, 50.6, 70.3 and 68.5, respectively. These data showed that the nutrition transportation in rice plants of M and M+F treatments were disturbed.

The results also suggest the rice tarsonemid mite may be one main cause for the occurrence of the mite induced sterility of rice plants.

18R-2,6

Polycheyletus boonkongae n. gn., n. sp., from Thailand (Cheyletidae, Acari).

P. Vaivanijkul (Biol. Dept., Chulalongkorn Univ., Bangkok 5, Thailand).

Polycheyletus boonkongae, n. gn., n. sp. (Cheyletidae, Acarina) is described from a mite taken from humus, Sakaerat Forest, Northeastern Thailand.

18R-2,7

ECOLOGY OF ORIBATID MITES IN RELATION TO SOIL MOISTURE

BY SOMNATH BANERJEE, Dept.of Zoology,
Suri Vidyasagar College, Birbhum,West Bengal
(I N D I A)

The paper presents part of an ecological investigation of the oribatid population of West Bengal.144 Soil samples were collected at monthly interval over a period of three years(from March,1971 to February,1974). The oribatid fauna belonged to eight species of which *Scheloribates thermophilus*, *Lamellobates bengalensis*, *Oppia yodai*, ~~and~~ *Tectocepheus velatus*,&*Eohypochthonius gracilis*, were numerically dominant. Maximum population was recorded in monsoon months (July-August) when the moisture content was the highest and minimum population in May when the moisture content was the lowest. Soil moisture showed appreciable changes with change of reason and their effect on the population was found to be significant.

18R-2,8 VERTICAL DISTRIBUTION OF ORIBATEI (ACARI:CRYPTOSTIGMATA) IN RELATION TO THE CHARACTERS OF SUBLAYERS OF Ao HORIZON IN JAPANESE CONIFEROUS FOREST SOIL.

TAKAKUWA,M.(Dept.Zool.,Kyoto Univ.,Kyoto)

Vertical distribution of Oribatei was investigated in relation to the characters of organic soil layers. Samples were taken by an improved technique which made it possible to split Ao horizon into sublayers such as L,F and H layers. *Tectocepheus velatus*, *Quadroppia quadricarinata*, *Oppiella nova* and *BRACHYCHTHONIIDAE spp*. were predominant in F and H layers, while *Fissicepheus clavatus* in L layer. Distribution of Oppia sp.A was restricted to H and deeper layers. Statistical analyses were undertaken by $C'\delta$ and $C'\lambda$ indices (Morisita, 1970). F layer showed the highest similarity among its samples and the maximum value about species number and density of Oribatei. It shows that F layer is favored by various species of Oribatei, and each species distributes uniformly. On the contrary, some species distribute contagiously in L layer.

18P,1 THE POPULATION DYNAMICS OF THE CITRUS RED SPIDER MITE, *PANONYCHUS CITRI* MCGREGOR, IN NORTHERN KYUSHYU.

MURAOKA, M. and SEKI, M. (Saga Fruit Experiment Station, Ogi, 845 Japan)

After hibernating on the leaves and twings of satsuma mandarin orange, the mites moved to the newly developed leaves in late May. In this season, the densities of eggs, larvae plus nymph, and female adults were 0.3-5.0, less than 1.0, and less than 0.1/leaf, respectively. The female adults increased gradually to 3.0-5.0/leaf in early July when the predacious insects such as *Stethorus japonicus* and *Oligota* sp.attacked the all developmental stages of the mites. Thc population growth of the mites was depressed with prolonging the rainy season. After the season, the mites steadily increased and reached to the maximum population, 15-20/leaf, then rapidly decreased to less than 1.0/leaf, and did not increase again. Under laboratory conditions, about 10% of eggs on leaves was washed off and the rate of oviposition decreased to about 50% after the artificial rainfall (10-20 mm/hour, 24 hours). In field conditions, the mites did not decrease after the rainfall, but did after typhoon to about 30-50% level of the initial population. The population dynamics of the mites in field was analyzed by the simulation model based on the relationships between the mites and the environmental factors such as temperature, rainfall, typhoon, predators, pesticides, and physiological conditions of the host plants.

18P,2 POPULATION DYNAMICS OF THE CITRUS RED MITE, *Panonychus citri*(McGregor), WITH SPECIAL REFERENCE TO THE DEMOGRAPHIC PARAMETERS.

Yasuda, M. (Lab. Appl. Ent. & Nemat., Nagoya Univ., Nagoya, 464 Japan)

To elucidate the existence of two population peaks of the citrus red mite in middle part of Japan, laboratory and field experiments on the population dynamics of this species were carried out. Demographic parameters [age-specific fecundity (m_x), age-specific survival rate (l_x) and intrinsic rate of natural increase (r)] of the citrus red mite were estimated under various temperatures.
In accordance with the relationship between temperature and r, the changes in r in relation to seasonal change in temperature through one year was estimated and compared with the actual population trend of the mite in the field. It was concluded that temperature was most important in explaining the two peaks.
The change in r in relation to changes in the patterns of l_x and m_x curves were calculated and effects of these parameters on r were discussed.

18P,3 APPROACH TO UTILIZATION OF COMPUTER FOR THE FORECASTING OF OCCURENCE OF CITRUS RED MITE.

Kashio, T. and Tanaka, M. (Kuchinotsu Branch, Fruit Tree Research Station, Kuchinotsu, Nagasaki 859-25, Japan)

A simulation model for the population dynamics of citrus red mite, *Panonychus citri* (McGregor) has been developed to apply the forecasting of occurrence of citrus red mite.

The model is constructed on the following feautures: the major compornents are development, oviposition, mortality, dispersal, consumption by natural enemies and rainfall effects; development, oviposition, mortality and dispersal are dependent on temperature, deterioration of host plant caused by population themselves and density, and consumption rate by natural enemies on temperature and density; individuals of citrus red mite on each stages (egg, young and adult) are divided into several age cohorts which are about one day age classes at 25°C and are represented as a vector; each compornents is evaluated in each time intervals of one day and the individuals of each cohorts move accordingly.

Validation of the simulation model with field derived data are conducted. From the results of simulation, the values of parameter of each compornents are discussed.

18P,4 EVIDENCE ASSURING EXISTENCE OF SPECIES SPECIFIC SEX ATTRACTANT FACTOR IN SPIDER MITES.

Attiah,H. and Farrag,A. (Dept. Biol., Sc. College, Sulaimaniya Univ., Sulaimaniya, Iraq).

Spider mites comprise red and green species. In Egypt Tetranychus cucurbitacearum (a red species) and T. arabicus (a green mite) can often be found in mixed populations. Experiments revealed a male of either species is predominantly attracted to quiscent deutonymphs belonging to its own species in presence of deutonymphs of the other species. Moreover, in mixed population of males and deutonymphs of both species, each male is much more attracted to its partner deutonymph.

Symposium.

Education in Entomology.

SE,1 ENTOMOLOGY EDUCATION IN UNIVERSITIES IN JAPAN. Matsumoto, Y. (Lab. Appl. Ent., Fac. Agric., Univ. Tokyo, Bunkyo-ku, Tokyo 113, Japan) and Saito, T. (Lab. Appl. Ent., Fac. Agric., Nagoya Univ., Chigusa-ku, Nagoya 464, Japan)

We present the our survey data on the present situation of entomological education in universities in Japan; the curricula, the number of staffs, the numbers of undergraduate students and graduate students in master's and doctor's courses, and their occupational chances. Then we also elucidate number of problems presently confronting us and discuss some possibilities to solve the problems.

SE,2 AGRICULTURAL ENTOMOLOGY TEACHING IN ARGENTINE UNIVERSITIES

Quintanilla, R.H. (Fac. Agr. Univ. Bs. Aires, Argentina)

This paper was prepared with the purpose of explaining how the Agricultural Entomology is teaching in the Argentine Universities with references of methodology and sistems of evaluation of the courses.

SE,3 ENTOMOLOGY EDUCATION IN USA. T. E. Skelton (Dept. of Entomology & Economic Zoology, Clemson Univ., Clemson, S. C. 29631 USA)

There have been recent changes in curricula to better prepare our graduates for changing opportunities in the entomological profession. Some of these changes will be discussed. Additionally, data will be presented on different courses offered at various educational institutions in the United States and on innovative teaching methods and materials. Emphasis will be on undergraduate education.

SE,4 ENTOMOLOGY INSTRUCTION IN THE CALIFORNIA COMMUNITY COLLEGES
GORELICK, G.A. Dept. of Biol. Sci., Citrus College, Azusa, CA. 91702 USA

A survey taken of 120 California community and junior colleges reveals the various method(s) and technique(s) used in the instruction of general or introductory lecture and laboratory courses in entomology. The data compiled strongly suggests uniformity with similar courses offered at American universities and four-year colleges yet reveals problems generally not encountered at the four-year institutions.

SE,5 EDUCATION IN ENTOMOLOGY IN CHINA.Tsai, J.H.(Univ. of Florida, Gainesville, FL 32611 U.S.A.)

This paper presents a chronological study of insects in Chinese history. The evidence on the use of silkworm can be traced as far back as 4700 years ago. Other examples of studying insect-man relationship in ancient Chinese history are also presented. However, the formal entomological curricula were not introduced in the college of agriculture until 1930. Because entomological education in China has gone through many changes since then, about ten transitional periods will be discussed in this paper.

SE,6 Entomological Training in Africa with special refe reference to Nigeria. Youdeowei , A. Uni. Ib. Nigeria.

In the Nigerian educational system, entomology is integrated into the curricula at the primary, secondary and tertiary level institutions. University level training includes postgraduate courses leading to masters and doctorate degrees in entomology. This paper also describes the institutional arrangements for training entomologists together with the job opportunuties available to the graduates Three new major programmes for entomological education in Africa are also described.

Movie Film Presentation.

F,2 THE MOVEMENTS OF THE SILKWORM ALIMENTARY CANAL.

Hukuhara,T.(Fac.Agric.Tokyo Univ. Agric.Technol.,Fuchu,183 Japan)

Observations were made on the movements occurring in the alimentary canal of intact larvae of the silkworm, Bombyx mori. The method of observation consisted of rendering the silkworm integument transparent by administrating melamine and illuminating the larval body by means of a concentrated beam of light. The major regions of the canal exhibited different patterns of movements. The pharynx exhibited rhythmic contractions. The esophagus usually remained motionless but occasionally there occurred a contraction or several contractions involving the whole esophagus. In the midgut contraction waves originating at various places were running; the contractions were highly rhythmic and continuous; and the waves proceeded both anteriorly and posteriorly from the centers of activity. Descending contraction waves regularly occurred in the small intestine and the colon. The rectum exhibited strong contractions at the time of defecation. The gut activities were depressed during the molt, and abolished when the larva was made hypoxic. The midgut activities were continued when the larva was paralized by injection of tetrodotoxin.

F,3 Simple biochemical detection and monitoring methods for resistance in green rice leafhopper.

Saito,T.,Miyata,T.,Ozaki,K.,and Hama,H. (Lab.Appl.Ent. and Nema., Fac.Agr.Nagoya Univ.,Nagoya,464 Japan)

To monitor the resistance of insect pests, bioassay methods such as topical application, dipping, spraying ect. are used. These methods need much number of insects and long time to get results. Organophosphorus insecticides resistant green rice leafhopper,*Naphotettix cincticeps*,showed a high nonspecific esterase activity. Optimum concentration of ATCh in methyl carbamates resistant leafhopper was higher than that of susceptible ones. Simple biochemical methods to monitor organophosphorus and carbamates insecticides resistant leafhoppers are developed. These biochemical assay methods are really simple and individual leafhopper of the population is assayed. People who work at the extention can easily monitor insecticide resistance in the laboratory or in the field.

F,4 PAST AND CURRENT STATUS OF RICE STEM BORER (CHILO SUPPRESSALIS) IN JAPAN.

Iyatomi, K. (Lab. Appl. Ent. & Nem., Meijo Univ., Tempaku, Nagoya, 468 Japan)

Rice stem borer, Chilo suppressalis, had been the most injurious pest of rice in Japan. Since 1963, a decreasing trend in population of the borer has been observed, and during recent years, the borers have been kept below the economic injury level. The decline of the population is considered to have been induced by a revolutional improvement of rice farming practices which were affected by socioeconomical changes.

1. Changes in rice varieties.
2. Development of transplanters and nursery boxes.
3. Early planting and harvesting.
4. Increased application of silicate fertilizers.
5. Mechanical harvesting.
6. Disposal of rice straw.
7. Others.

F,5 The phenology and migration of the seven spotted ladybird *Coccinella septempunctata* L. on Mt. Meron, Israel.

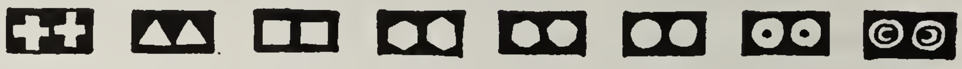
Rubin, A. (Nat. Res. Auth. Tel Aviv, Israel)

From '79 phenology & aggregation of *Coccinella septempunctata* was studied on Mt. Meron (1208 m), Israel. Adults migrate in mid-May and estivate under stones on the mountain until October. During sunny days in Oct. some adults feed on aphids. Between Nov. to January adults hibernate again under stones. In Feb. they migrate to lower mainland, copulate and lay eggs. Larvae feed on aphids in orchards and crop fields. New generation emerges in April from pupae. All of them aggregate and migrate back to high mountains in May. Ca. 80% of the adults are attacked by *Beauveria bassiana*.

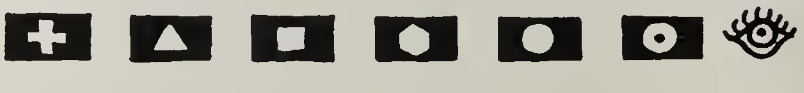
Monthly counts of adults at the top of Mt. Meron showed appearance of 223-326 adults (during 5 minutes) in May on *Spartium Junceum* L. (Papilionaceae). Between June to Jan. average counts were 0-5. From Feb. to Apr. usually adults disappeared. Marking with colour & radioisotopes to study direction and distance of migration, are under investigation.

F,6 PROTECTIVE FUNCTION OF EYESPOT PATTERNS IN CATERPILLARS.

Shirota, Y. Yamaguchi, R. (Lab. Ent., Fac. Agric., Hirosaki Univ., Hirosaki, 036 Japan)



Blest experimentally demonstrated that eyespot patterns on the wings of certain species of the Lepidoptera have a protective function against predation by birds. Eyespot patterns are also found in some lepidopterous larvae. Whether they have a protective function or not is still open to question. To answer this question we have been analyzing the gray starling's (*Sturnus cineraceus*) response to artificial eyespots fixed on both sides of the thorax of larvae of silkworm (*Bombyx mori*). The bird's response to artificial eyespots was related to the size of the eyespots, i.e. large eyespots exerted an intimidating effect and small ones a deflecting effect. In selective predation experiments a larva with eyespots was put on the floor of the experimental cage at a distance of 10 cm from a 'control' larva (without eyespots), and we observed which one was attacked first. The control larvae were clearly preferred to those with eyespots, and it was discovered that even artificial eyespots which did not look like snake's eye had a protective effect to the birds.



F,7 NEST BIOLOGY OF THE STINGLESS BEE *SCAPTOTRIGONA POSTICA*.

Engels, W., Engels, E. (Lehrst. Entwicklungsphys., Univ. Tübingen, D-74 Tübingen, Germany) and lots, G., Camera Dröscher, R. and Wittmann, H. (Inst. f. d. wiss. Film, D-34 Göttingen, Germany)

In comparison with honeybees, little is known about the biology of the second group of bees with a eusocial organisation, the stingless bees. This is a consequence both of the tropical distribution and the difficulties in observing activities within the nest, because most of the species use small cavities as nesting sites. For the purpose of this film record, colonies therefor were placed in special observation boxes. Illumination without any disturbing effect was managed by means of a series of synchronized flash lights. The film begins and ends with outdoor activities: Foraging and defense behavior. Most of the content demonstrates the nest construction and the different indoor activities of this species originating from Brazil: Storage of pollen and nectar in pots, building behavior on involucrum and brood cells which are arranged in layers of only one times used horizontal combes, provisioning, oviposition by the queen, alimentary eggs, gueen cells, nest hygiene and conditioning, emerging brood.

F,8 An enemy in our forests :on Dendroctonus bark beetle

Rudinsky, J.A. (Dept. Ent. Oregon State Univ. Corvallis, Oregon 97331, USA).

F,9 REPRODUCTIVE BEHAVIOUR OF PALAEMNEMA PAULITOYACA CALVERT. González-Soriano,E. and Novelo-Gutiérrez,R. Directed by Novelo,R.; Photography by Ruiz,J.; Edited by Aguilar,J.L.; Realization Lab. de Cine Científico, Facultad de Ciencias, UNAM, Ciudad Universitaria, México 20, D.F. , México.

A cinematographic record of the reproductive behaviour of Palaemnema paulitoyaca Calvert is presented.

The most outstanding feature of this species is the uncommon type of oviposition using as a substrate, several non-acuatic woody plants. This is the first film record on this type of behaviour in the world.

F,10 EDIBLE INSECTS IN MEXICO WITH SPECIAL EMPHASIS IN LIOMETOPUM A PICULATUM

Ramos-Elorduy,J. and Cuadriello,I. Directed by Ruiz-Cortés,J.;Photography by Novelo-Gutiérrez Rodolfo Edited by Guerra,M.C. Coproduction Institute de Biología-Facultad de Ciencias,UNAM, Ciudad Universitaria, México 20, D.F., México.

In this film, several insects eaten by people in Mexico are presented. Special emphasis is made on Liometopum apiculatum , an edible ant, touching different aspects concerning their biology, ecology behaviour and nutritive value.

Evening Meeting.

Ev-5,1 Biological Phenomenon of Immigrant Species with Special Reference to Plant Pests.
K. C. Kim (Dept. Ent., Frost Ent. Mus., Penn State Univ., University Park, PA 16802 U. S. A.

Various aspects of the biological phenomenon of immigrant pests will be discussed.

Ev-5,2 Distribution Pattern of Immigrant Species
J. R. Lattin (USA)

Ev-5,3 Genetics of Colonizing Species
I. C. McDonald (USA)

Ev-5,4 THE IMPORTANCE OF COMMERCE AND TRANSPORTATION ON THE COLONIZATION OF IMMIGRANT PLANT PESTS.

Chilson, L.M. (Regulatory Entomology Consultant, Silver Spring, MD., 20904, U.S.A.)

The traditional concept is that man's commerce and transportation between naturally isolated geographic and climatic regions results in increasing number of newly established pests. This concept is analyzed to determine its validity. Factors are identified that have an influence on the predictability of whether certain kinds of pests will be dispersed and colonized. It is shown that the variations in man's activities, such as the types of commerce and carriers, and the efforts of man to regulate pest movements, are as important as the natural barriers for preventing establishment. These factors, in conjunction with some of the obvious biological factors, have been utilized in the past to predict probability of establishment. Some previous models which attempt to predict this potential are evaluated.

Ev-5,5 ESTABLISHMENT OF BENEFICIAL ORGANISMS IN NEW ECOSYSTEMS.

Huffaker C., and Hoy, M.
(Dept. Entomol. Sci., Univ. California, Berkeley, Calif. 94720 U.S.A.)

The discipline of biological control has had extensive experience with attempts by man to deliberately introduce from foreign ecosystems to domestic ones a vast array of natural enemies of various, mostly crop pests. Thus, these deliberate colonization attempts present us with a wide scope of examples from which we can assess some of the factors affecting unsuccessful and successful man-introduced "invasions" of colonizing species.

Foremost among the important factors mitigating against successful colonization is a suitable matching of the organisms to the new, for them, exotic conditions. This array of new conditions embraces first of all those of the physical environment, and these may be intimately modified by, or interact with, the different faunal and floral elements in the new environment. A second feature is the hazard imposed by other organisms already present or, in the case of essential allies, of their absence. Thus, finely tuned pre-adaptations may be required to obtain sufficient match that first colonizers can reproduce at all and thereby initiate a process of evolutionary change improving upon the degree of pre-adaptation of the initial colonizing phenotypes. The size and diversity of sources of the colonizing group(s) as well as the genetic makeup of these potential colonizers is often critical.

The records of successes and failures, and what little has been done to engineer or improve fitness as a means of improving colonizing success of certain natural enemies is examined.

Ev-5,6 Colonizing Species: Implications for Evolutionary Biology

C. Remington (USA)

Satellite Meeting.

St-1,1

STATUS OF RESEARCH ON THE GENETICS OF *CULEX TARSALIS* DIRECTED TOWARDS INTEGRATED CONTROL.

Asman, S.M. and McDonald, P.T. (Dept. Ent., U. Calif., Berkeley, CA 94720

The perfection of any genetic control system, while categorized as applied research, necessarily includes the development of extensive basic research on the target species, primarily on its biology and ecology in the field. To date 30 reciprocal translocations have been induced and identified by the use of 17 multiple-marker lines constructed from 14 established monofactorial mutant stocks of *Cx. tarsalis*. A double sexlinked heterozygous interchange inherited by males only,and which reduced egg hatch 75% was evaluated in pilot field studies. These studies indicated that the experimental males could be mass-produced, released successfully, could mate with wild-type females, and could survive in the field as immatures and adults. Data also indicated that the release might well have contributed to a reduced field population, even though parallel experiments confirmed the genetically-altered line had lost its initial competitiveness over a year's time. This observation initiated a new area of research in quality control to improve the fitness of all lines involved in competition studies and/or release experiments. Three homozygote and 1 "pseudohomozygote" translocation lines are being evaluated for genotype replacement studies. A line of *Cx. tarsalis* incompetent as a vector of WEE virus has been selected and could serve as a desirable genotype for population replacement. A pilot field sterile-male release suggested that this approach could be a useful technique for suppression of isolated populations, or perhaps as 1 system of an integrated-control approach. Three years of mark-release-recapture studies have provided important background data on native *Cx. tarsalis* populations relative to their biology and ecology. Studies are in progress to isolate a genetic sexing mechanism based on insecticide resistance linked to a male-determining factor and closely bound sex-linked interchange.

St-1,2

RECENT ADVANCES IN CYTOGENETICS OF CULICINE MOSQUITOES.

Rai, K.S. (Dept. of Biol., Univ. of Notre Dame, Notre Dame, Indiana, U.S.A.).

Considerable work has been done on several aspects of cytogenetics of culicine mosquitoes during the last two decades with particular attention on two genera : *Aedes* and *Culex*. These studies have included (a) karyotype analysis of 56 *Aedes* sp. and 24 *Culex* sp. representing relatively small samples of 6.2% and 3.9% of the total species in these two genera respectively, (b) cytogenetics of chemically and radiation-induced sterility, (c) cytogenetics of radiation-induced chromosomal rearrangements and their extensive use in correlating linkage groups with chromosomes, cytological mapping of genes on individual chromosomes and for genetic control and replacement purposes and (d) cytogenetics of sex-ratio distortion. Most of these studies have utilized *Aedes aegypti*, *Culex pipiens*, *C. tritaeniorhynchus* and more recently *C. tarsalis*.

More recently the emphasis in *Aedes* is shifting to an analysis of chromosomal basis of speciation through (a) application of chromosomal banding techniques, (b) meiotic pairing relationships in species hybrids, (c) comparative genetics and (d) electrophoretic variability. Although the diploid chromosome number in all species examined is six, extensive chromosomal repatterning is evident with as many as 12 distinct karyotypes in *Aedes*. Preliminary evidence suggests that both inversions and reciprocal translocations and changes in amount and distribution of heterochromatin have been utilized in the speciation process. Furthermore extensive chromosomal polymorphism has been observed in *A. bahamensis*.

In addition, Giemsa C-banding patterns in interspecific hybrids among *A. aegypti* and *A. mascarensis* have revealed the presence of constitutive and facultative heterochromatin and a novel mechanism of genetic regulation of a selective chromosomal locus in the former species involved in control of adult male development.

St-1,3

RECENT ADVANCES IN THE GENETICS OF CULICINE MOSQUITOES.

Chowdaiah, B. N. (Dept of Zoology, Bangalore University, India)

In addition to obvious practical problems relating to disease transmission and control techniques, studies with mosquitoes on aspects of Genetics, Evolution and Speciation have attracted very keen attention at present. The challenge posed by the insecticide resistance problem has resulted in the production of some valuable contributions to our understanding of vector genetics during the past decade.

This paper reviews briefly some important contributions which have appeared during the recent years pertaining to various aspects of genetic studies of culicine mosquitoes. These include mainly Formal Genetics, Biochemical Genetics, Linkage studies, Sex-determination, Genetics of susceptible and refractory strains, Genetics of Autogeny, Genetics of insecticide resistance, Behaviour Genetics and Genetic manipulation.

St-1,4

RECENT GENETICAL STUDIES ON THE MOSQUITO *AEDES AEGYPTI*.

Wood, R.J., Ouda, N.A., Pearson, A.M., and Malcolm, C.A. (Dept. Zool., Manchester University , M13 9PL, U.K.

Resistance to the Y-linked meiotic drive gene *D* (M^D) is strongly influenced by a recessive sex-linked gene *t* (*tolerance*) recombining with the sex determining region and located close to *re* (*red eye*). The effect of *t* will be discussed in relation to other influences on *D*.

The position and action of other genes recently located will be discussed. These will include *bw* (*brown eye*) on linkage group II which gives colourless eyes by epistatic interaction with *re*, and R^{py} on linkage groupIIIwhich gives resistance to synthetic pyrethroids and is probably allelic with R^{DDT2}.

St-1,5

The fromal genetics of *Aedes togoi*. Tadano, T. (Dept. Med. Ent., St. Marianna Univ., Kawasaki, 213 Japan)

Genetic research has been done on *Aedes (Finlaya) togoi*, a vector of various filarial species, for the past several years in our laboratory to accumulate materials which will be utilized for genetical analysis of the vectorial capacity or biological studies of the vector. So far 14 mutant loci have been determined in three linkage groups of this mosquito species as follows:

Linkage group 1: *n*—32 map units—*rd(M)*—25—*dv*—5—*s*

Linkage group 2: *ca*—8 map units—*ru*—30—*p*—30—*ha*—15—*w*

Linkage group 3: *pm*—40 map units—*y*—3—*sa*—20—*c*

15 more mutants are currently under study for establishment of the linkage maps in this species.

St-1,6

GENETICS AND CYTOGENETICS OF *ANOPHELES CULICIFACIES*. Baker, R.H. and Sakai, R.K.

(International Health Program, University of Maryland, Baltimore, MD 21201 USA)

Colonization has facilitated genetic studies involving spontaneous and induced morphological mutations, enzyme polymorphisms, polytene and mitotic chromosomes, the induction, isolation and cytogenetic characterization of chromosomal aberrations on all three chromosomes, and the correlations of the linkage groups with the respective chromosomes. Two different translocations, an autosome-autosome and an X-linked translocation, have been made homozygous, and an efficient method for producing additional translocations has been described. Sex determination is an XX-XY chromosome mechanism, and the evidence from analysis of triploids suggests that unlike *Drosophila* the Y-chromosome is important in male determination. Translocations involving the short arm of the Y chromosome appear completely linked without apparent crossing over to the X chromosome, but translocations involving the long arm may cross off to the long arm of the X chromosome. This suggests that part at least of the long arm of the X and Y chromosome are homologous, and that the sex determining mechanism is probably located in the short arms of the X and Y chromosome which also appear dimorphic. A genetic sexing mechanism involving dieldrin resistance has been developed. In preliminary field releases, males carrying a complex aberration appeared to be competitive with wild males.

St-1,7

VECTOR GENETICS OF SPECIES IN THE *ANOPHELES GAMBIAE* COMPLEX.

White, G.B. (Dept. Ent., London School of Hygiene & Tropical Medicine, WC1E 7HT, UK).

Anthropophilic *An.gambiae* complex mosquitoes are vectors of human malaria (*Plasmodium* spp.), filariasis (*Wuchereria bancrofti*) and arboviruses in the Afrotropical Region. Specific polytene chromosome banding sequences distinguish the sibling species *arabiensis*, *gambiae*, *melas*, *merus*, *quadriannulatus* and "species D". By cytotaxonomic identification of the wild adult females it has been found that ecological and behavioural divergences lead to contrasted vector capacities in the six members of the complex. Some aspects of intraspecific variation appear to be correlated with chromosomal inversion polymorphism, especially in *arabiensis*. Although heritable refractoriness to *Plasmodium* (*P.berghei*) has been demonstrated for *gambiae* s.s. in the laboratory, there are no indications of insusceptible individuals (to *P.falciparum* etc.) in wild populations of *arabiensis* or *gambiae*. The Human Blood Index is generally higher in *gambiae* than in *arabiensis* wherever they are sympatric in most parts of Africa, so that the former tends to be more efficient as a vector of human parasites. Zoophilic individuals of at least *arabiensis* transmit *Setaria labiatopapillosa* among cattle. Natural infections of both human malaria and filaria parasites have been found in *melas*, *merus* and sp.D. These three species are therefore regarded as locally important saltwater-breeding vectors of disease. By contrast, *quadriannulatus* is almost completely zoophilic and of no known medical importance. Interspecific hybridization occurs at frequencies of up to 0.02, producing sterile male and fertile female progeny. The latter sometimes backcross in nature, causing limited genetic introgression. However, the biological integrity of each sibling species is maintained. The effectiveness of vector control measures must therefore be monitored separately for each member of the *An.gambiae* complex.

St-1,8

GENETICS OF *Anopheles stephensi*

Sharma, V.P. (Mal.Res.Cent.,22 Sham Nath Marg, Delhi-54

Anopheles stephensi is an important vector of malaria in the Indian sub-continent and the middle east. Genetic studies with the phenotypic markers in *A. stephensi* type form revealed that red-eye is a sex linked recessive mutant while *colorless-eye*, *green-larva* and *greenish-brown* larva are recessive autosomal mutants. It also was revealed that *A. stephensi* has X, Y sex-determining mechanism as in *Drosophila*. Linkage studies have shown that there are 3 linkage groups i.e. linkage group I involving sex-linked genes, and linkage group II and III involving autosomal genes. Studies on the inheritance pattern of dieldrin resistant gene revealed that both complete and incompletely dominant genes are present in the Indian populations.

St-1,10

EVOLUTIONARY GENETICS OF ANOPHELINE VECTORS IN EAST ASIA AND WEST PACIFIC AREA.

Tozo *Kanda*. (Dept. Med. Zoo, St. Marianna Univ., 2095 Sugao, Takatsu, Kawasaki 213,Japan)

Among several group complexes of Anopheline vectors in East Asia and West Pacific Area, the *Anopheles* (A) *hyrcanus* complex, the *A. leucosphyrus* complex and the Pyrethrophorus group will be emphasized in this contribution. In the evaluation of these complexes cross-mating experiments, cytogenetical observations and analysis of protein molecules represented by spots in two dimensional electrophoresis (T.D.E.P.) as one of biochemical genetics are much demanded. The related groups were either divided into separate individual species, complex species, semi species, sibling species, sub species or local groups. The results are briefly summarised as follows :-

The relation between *A. lesteri* and *A. paraliae* is that both can be considered as sub species and the genetic distance calculated from the results of TDEP was apparently larger than that of intra or inter strains of *A. lesteri*. *A. engarensis* and *sinensis* are morphologically similar sibling species isolated reproductively. *A. sineroides* banding pattern in the chromosome complements is homologous to *koreicus* but not to *sinensis* and these three are reproductively isolated. Among the 7 morphologically distinguishable members of the *hyrcanus* complex, the cross tests showed parallel results to that of TDEP with some exceptions. The protein differences in results of TDEP between respective two combinations were smaller in the ones which are capable to obtain the F_1 hybrid adults than in the ones which are incapable. In the *leucosphyrus* complex and the Pyrethrophorus group, 3 members of each were investigated by similar methods. The respective three were reproductively isolated species which are capable of giving F_1 hybrid adults and the hybrids were mostly sterile males.

St-1,11

CHROMOSOMAL MANIPULATION STUDIES OF *ANOPHELES ALBIMANUS* FOR GENETIC CONTROL. Seawright, J. (Agr. Res., SEA/USDA, Gainesville, Florida USA 32604)

For the past 5 years, an investigation has been conducted on the development of genetic control mechanisms for *Anopheles albimanus*. A genetic sexing system, allowing the preferential killing of females, was synthesized and implemented in a mass production facility. Our other studies have been concentrated on the isolation and characterization of large, pericentric inversions and whole-arm reciprocal translocations. The translocations are being combined to make "capture" strains for compound chromosomes. These studies on chromosome aberrations will be discussed in relation to their potential usefulness for mosquito control.

St-1,13

POPULATION GENETICS OF INSECTICIDE RESISTANCE IN MOSQUITOES

Curtis, C. F. and Davidson, G. (Ross Inst., London Sch. of Hyg. & Trop. Med., London WC1E 7HT, U.K.)

Resistance now poses a definite threat to the useful life of the limited number of insecticides available for mosquito control. Any strategy aiming at preventing or slowing down the appearance of this resistance is to be encouraged. A study of heterozygote survival under field conditions would seem essential and the maintenance of deposits lethal to this genotype desirable. The simultaneous application of more than one insecticide in contiguous areas of such a size that significant exchange of mosquitoes occurs between them merits investigation as a counter-selection method. The insecticides would need to be unrelated and unlikely to select a common resistance mechanism. The periodic release of susceptible males would reinforce this method.

St-1,14

GENETICS AND CYTOGENETICS OF THE GERMAN COCKROACH. Ross, M., Dept. Entomol., Va. Polytech. Inst. & State Univ., Blacksburg, VA 24061 (USA)

The genetics and cytogenetics of the German cockroach, Blattella germanica (L.) is viewed from the perspective of twenty years of study. The stocks available for research include 62 visible mutants, twenty reciprocal chromosome translocations, and several double translocation heterozygotes. Highlights of past research are noted, especially those pertinent to current cytogenetic analyses of translocation heterozygotes. The involvement of certain chromosomes within an interchange complex apparently increases their chiasma frequency, resulting in a significant increase in chiasma frequency/individual. The frequency of adjacent orientations of ring quadrivalents correlates closely with embryonic lethality as estimated from examination of mature oothecae. Times of embryonic death vary with the particular interchange but, in general, tend to occur during early stages of development. The frequency of alternate vs adjacent disjunction is influenced by genotype. The manipulation of sex differences in disjunction makes possible the development of double translocation-carrying males which, on mating, cause complete egg case sterility from the combined effects of genetic load and embryonic trapping (the death of fully-developed viable embryos due to their reduced numbers with resultant inability to force open the egg case). These sterile males were utilized in a first attempt to integrate a genetic mechanism with insecticide treatments for control of the German cockroach. Dispersal following treatment was followed by the development of infestations at new harborages well removed from release sites (initial infestations). Wild-type population growth at these new sites was the major contributor to population growth during the 4½ mo the experiment was in progress. The sterile males joined groups close to release sites where they apparently competed well against wild-type males.

St-1,15 Some Cytogenetical Aspects of Tsetse Fly Chromosomes

D.I. Southern, Manchester University, England.

It has been known for many years that certain species of tsetse fly display ecological versatility and several atypical populations have been described. Recent genetical and ultrastructural studies have uncovered a wide spectrum of variation and it is becoming accepted that many species formerly regarded as monotypic are in reality quite plastic. This intraspecific diversity is reflected in chromosome variability and examples of sex chromosome aneuploidism, supernumerary B chromosome systems and Giemsa C-band polymorphisms, are described.

St-1,17 "An overview of the application of genetics in the study and control of insect vectors of disease", PAL, R., WHO, Geneva.

For many years it has been recognized that a number of aspects of genetics are directly or indirectly important in the prevention and control of vector-borne diseases, for example: cytogenetics, ecological genetics, behavioural genetics, genetics of vector susceptibility to parasites. Studies on genetics are important for the sound understanding of pesticide resistance and the development of genetic control methods. WHO convened a meeting of experts in 1976 to discuss species complexes in insect vectors of disease and presented a summary of species complexes in blackflies, mosquitos and tsetse flies. In 1978 WHO convened a meeting of experts to discuss various aspects of vector ecology and behaviour, including genetics. Indeed, genetic change is the response of the species to changes in its environment. Thus, a thorough knowledge of the genetics of a vector is fundamental in developing basic control strategies with the co-evolution of the vector, its hosts and its parasites. The group suggested further areas of research to fill the lacunae in our knowledge. Earlier in the 1970's, WHO initiated a programme of work on the genetic control of insect vectors of disease which has been well covered in a number of publications. Genetic control *per se*, however, has been assigned high priority only in relation to the sterile male technique for *Anopheles* and tsetse fly control, although some work was also carried out on *Culicine* species. This paper endeavours to present an overview of the application of genetics in the study and control of insect vectors of disease, giving specific examples in each case.

Addendum to Symposium 3S-3.

COMPARATIVE ASPECTS OF INSECT CUTICLE LIPIDS. Jackson, L. L. (Chemistry Dept., Montana State University, Bozeman, Montana 59717)

The cuticle of insects, like most terrestrial organisms, is covered by a thin film of lipid. Insects in an aquatic environment generally have less cuticular lipid. A few insect have been studied for cuticle lipids through their life stages and the similarities and differences will be discussed. From many insects and generally from the most studied insects, hydrocarbons account for the major component of the cuticular lipid coating. Several cuticular hydrocarbons have been shown to function as sex pheromones, mating pheromones, kairomones and alarm-defense substances. The insect hydrocarbons vary from insect to insect but the general classes are n-alkanes, 3-methylalkanes, n-alkenes, n-alkadienes, n-alkatrienes, internally branched monomethylalkanes, dimethylalkanes and trimethylalkanes. The non-hydrocarbon portion of the cuticular lipid has been studied in only a very small number of insects but greater attention is and should be paid to these components.

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